LUNAR SITE PREPARATION VEHICLE FOR NASA

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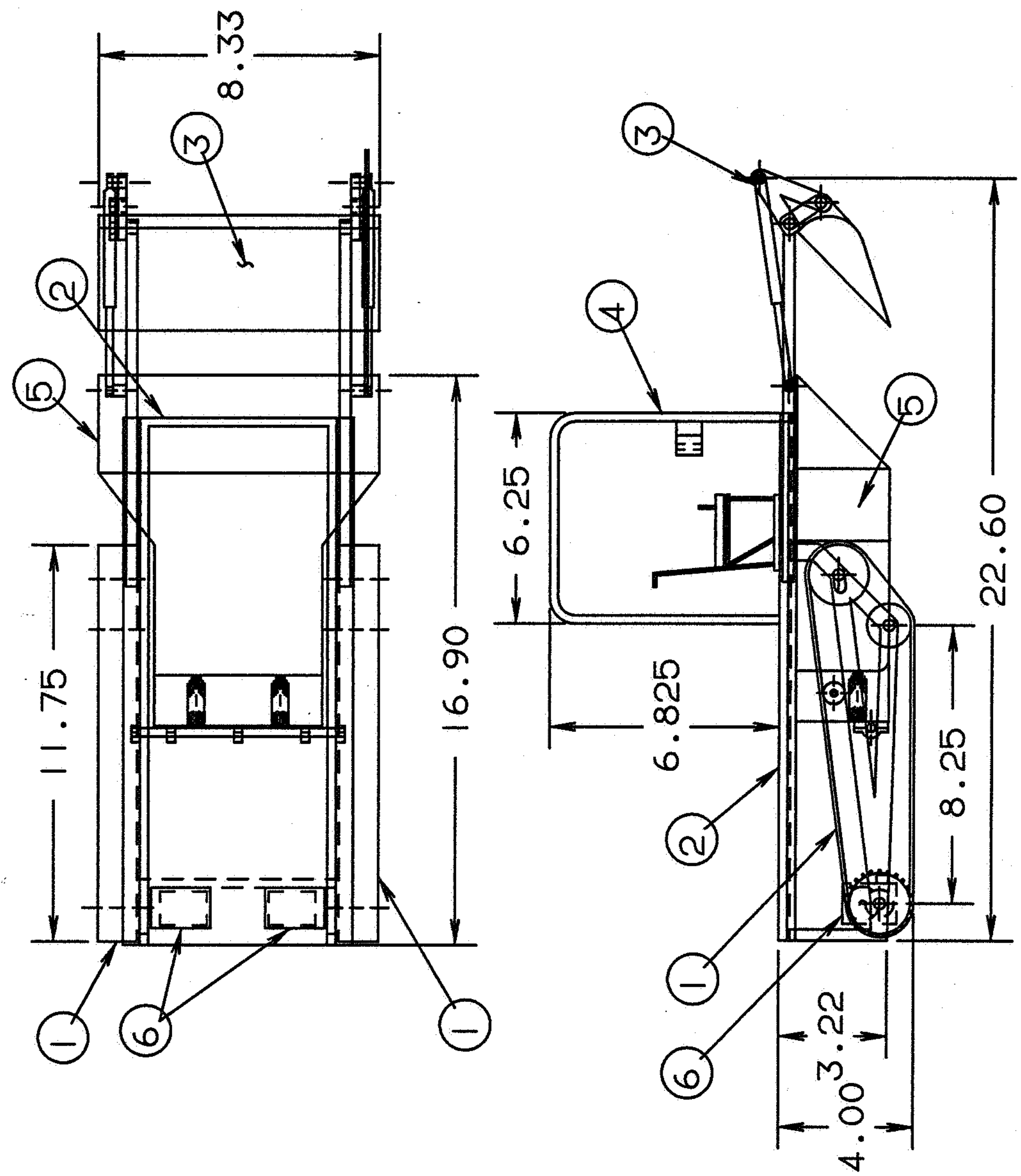

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Problem Statement

Lunar Site Preparation Vehicle For NASA

Team TH 3:30

The problem to be solved by this Design Project is that of Lunar surface preparation for the eventual construction of a lunar space station. We are proposing to NASA a design for a vehicle that will transport lunar soil as an aid in the civil engineering effort. The proposed vehicle shall include a form of scooping up 3 cubic yards of lunar soil and directly depositing it into a bin. Once the bin is full, the mobile assembly will deposit the payload at another preselected site within a 300 yard radius. The vehicle shall operate at least 6 hours on one charge with an average removal rate of 18 cubic yards per hour. The vehicle when fully laden shall be capable of climbing an incline of no less than 14 degrees from horizontal at any time during a charge.

Prior to assembly, the largest subassembly shall be no more than 4 feet high, 22 feet long, and 9 feet wide. The maximum permissible subassembly weight shall be 2500 earth pounds.

Major materials technology considerations are radiation effects, dimensional stability and thermal control coatings. Materials will be subject to repeated thermal cycles of +/- 125 C, ultra violet radiation, vacuum in the range of 10E-11 to 10E-19 Pa, space debris and large doses of high energy protons and electrons. Advanced graphite reinforced composites are among the best material choices. Aluminum and titanium treated with long-life coatings (required to keep the vehicle within design temperature limits) will also be investigated.

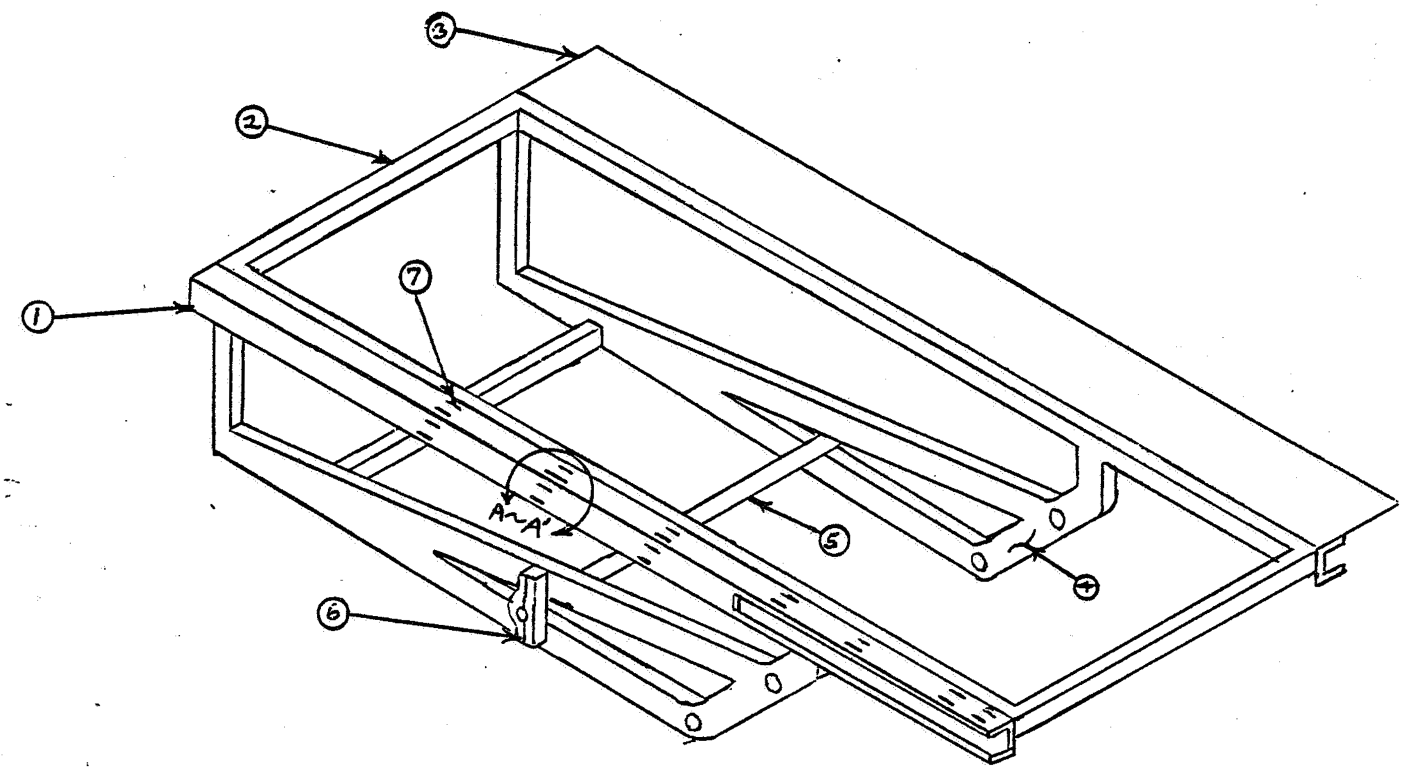
Our design shall minimize the number of moving parts which create frictional heat dissipation problems. Furthermore, the required maintenance shall be minimized due to adverse conditions affecting the repair and obtainment of replacement parts.

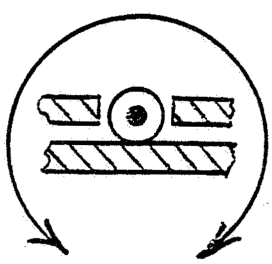
System Details

The Lunar Surface Preparation Vehicle that we are proposing is comprised of 9 major subsystems. They are:

1. Frame
2. Tracks
3. Scoop
4. Pan
5. Cab
6. Power
7. Hydraulics
8. Thermal Controls
9. Drive Controls

Frame Subassembly





SECTION A~A'

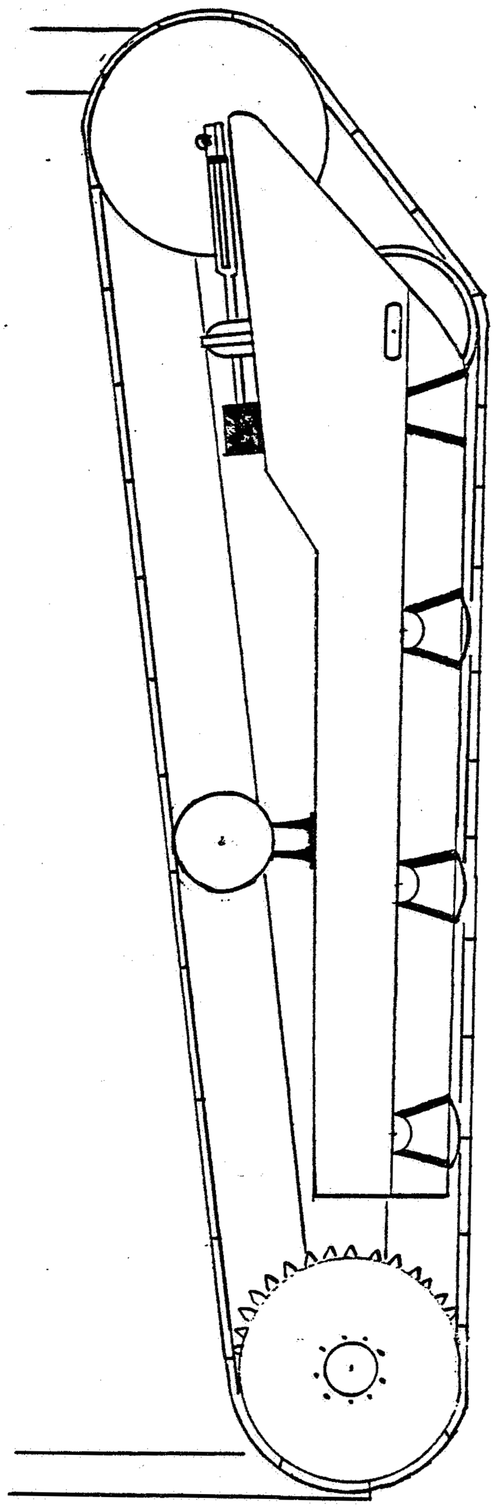
SUBSYSTEM: FRAME

ITEM#	QTY	DESCRIPTION	VENDOR	COST
①	2	6"X6"X21'1" SQUARE 2024 AL. TUBBING	TULL METALS	$1112
②	2	4"X4"X 21'.1" SQUARE TUBBING 2024 AL.	TULL METALS	$ 710
③	2	4'X8'X 1/8" SHEET STOCK 2024 ALUMINUM	TULL METALS	$ 230
④	2	4"X6"X 25' RECTANGULAR SOLID 2024 ALUMINUM.	TULL METALS	$2880
⑤	1	3" DIA. X10' STEEL SHAFT	TULL METALS	$ 380
⑥	2	3" I.D. STEEL PILLOW BLOCKS	BROWNING	$160
(7)	40	03 SERIES STRAIGHT ROLLER BEARINGS, 10mm BORE X 40mm OD. X 15 mm WIDTH	BROWNING GEAR ENGINEERING	$ 300
⑧	40	3/8-24 X 2" HIGH STRENGTH STEEL BOLTS	CENTURY FASTNERS	$ 50

The frame subassembly is the basic box on which the other subassemblies are mounted. The accompanying figure shows the pivot shaft for the pan subassembly mounted in pillow blocks.

The majority of the frame is aluminum rectangular solid and square tubing. The fenders will serve to control dust and to hold hydraulic fluid radiators for cooling the fluid. Roller bearings (shown in section) are utilized to guide the extension of the scraper from the frame.

Track Subassembly



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The traction drive torque requirement has been based on a wheel/soil friction coefficient of 0.6 for maximum speed and maximum torques for negotiating 14 degree slopes. Each track is driven separately by a hydraulic motor,and vehicle braking is supplied by hydraulic motor shaft brakes which use oil baths to dissipate heat efficiently.

The tension on the track is controlled by a hydraulic piston mounted to the main frame. This allows the tracks to easily be removed when in need of repair.the track is turned by a sprocket and is directed along two idlers and three rollers. Periodic stops need to be taken during operation to allow the sprocket and chains to cool down, this being due to high friction.

FENDER

The fender should be made of a light material with minumum strength characteristics. The part will be continually exposed to radiation, cosmic dust, and sudden temperature changes. These factors must be considered because they cause significant changes in the mechanical properties of materials. Ductility should also be high since the material will be bent to a certain shape.

The Al-Cu-Si alloys have good mechanical strength, and with a high Si content, a useful series of alloys of excellent corrosion resistance can be chosen from. Al also has a melting point of 660 C. Magnesium can also be added to improve ductility. The Al alloy selected for the fender should be chosen from the work-hardening (non-heat-treatable) wrought alloys group of high corrosion resistance and high ductility.

TRACK SHOES

The tracks must be made of a high strength material that is high temperature resistant. Many material processes can be considered when choosing the material (ie. cast, forged, or machined). A light material is preferred to limit power consumption. Titanium alloys have the best combination of strength and lightness at temperatures tested to be too high for aluminum alloys. Ti can be forged under controlled hot-working ranges. It also exhibits extremely good wear and corrosion resistance. Ti has been chosen for the tracks shoes.

IDLERS, CHAIN & SPROCKET

The idlers and chain & sprocket assembly will be exposed to very high temperature conditions due to friction. The material must have high strength and good casting or machining properties.

The high strength and toughness that can be achieved in alloy steels are factors that make them suitable for our use. Steels which are hardened by martensitic transformation achieve high temperature properties with some sacrifice of room-temperature strength. The steel alloys possess an excellent combination of mechanical properties and they are not difficult to fabricate or weld. The corrosion resistance is certainly not as high as would be desirable, but the actual rate of corrosion is fairly low.

TRACK FRAME

The main strip, which is a guide for the chain, needs to be made of the same material as the chain & sprocket. It will operate under high temperature conditions and needs to have high strength.

The guards for the main strip and chain will prevent any debris from lodging in the chain. It will not require the same strength characteristics as the chain. An aluminum alloy would provide the needed corrosion resistance, and strength for the guards. Aluminum can easily be machined to the desired shape.

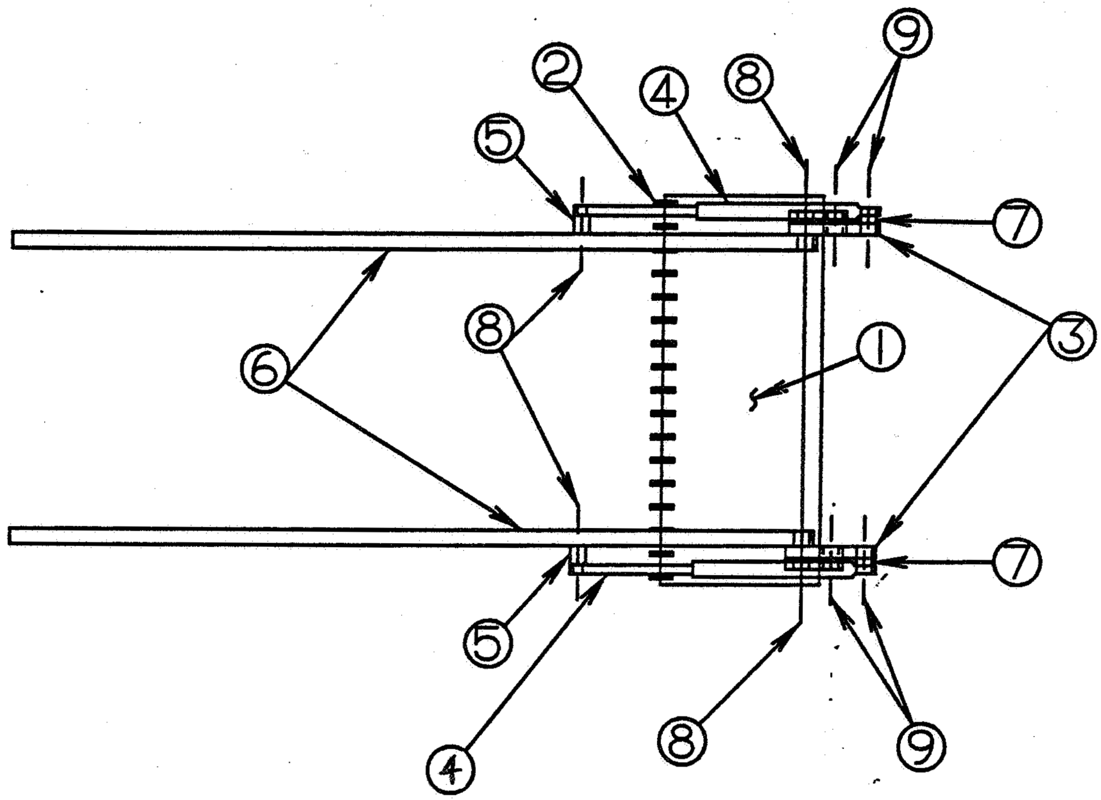
LUBRICANTS

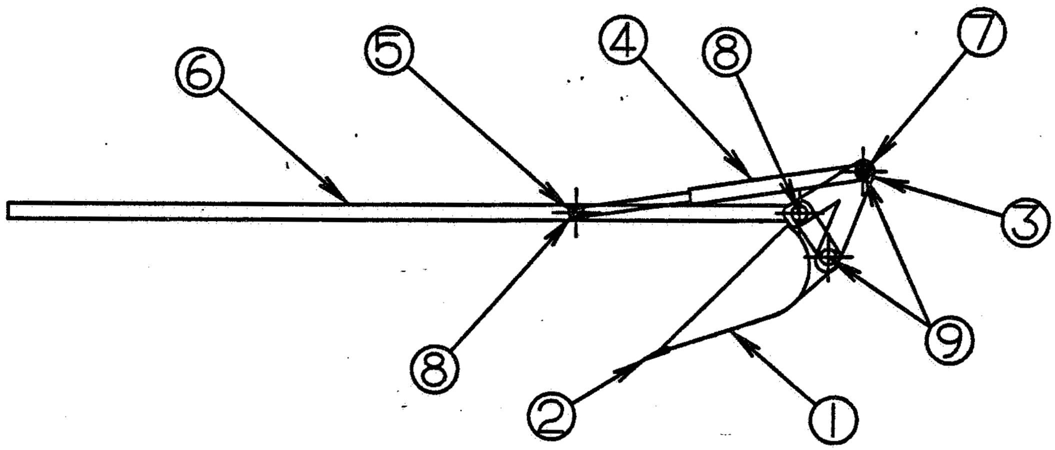
The behavior of materials under conditions of contact friction is a serious problem at low pressures. The materials that perform most successfully are those which form weak pressure-welded joints (ie. lead, steel, aluminum, and copper). But even these are unsatisfactory at very low pressures. If the bearing surfaces can be surrounded by a vacuum-tight enclosure, then normal lubrication methods can be adopted. One of the silicons, because of its low vapor pressure, would be advantageous if a vacuum-tight seal is not possible. Some of these are reported as having operated successfully for several thousand hours at 10E-5 mm Hg pressure.

BRAKES

Hydraulic motor shaft brakes provide consistent braking torque, positive hold, and long life. The high repeatability in performance is due to a wet braking system which supplies an oil bath for various parts to operate in. The seals for the brakes need to be modified to account for the low pressures encountered in space. Teflon seals provide the necessary requirements under these conditions. TFE seals are specified.

Scoop Subassembly



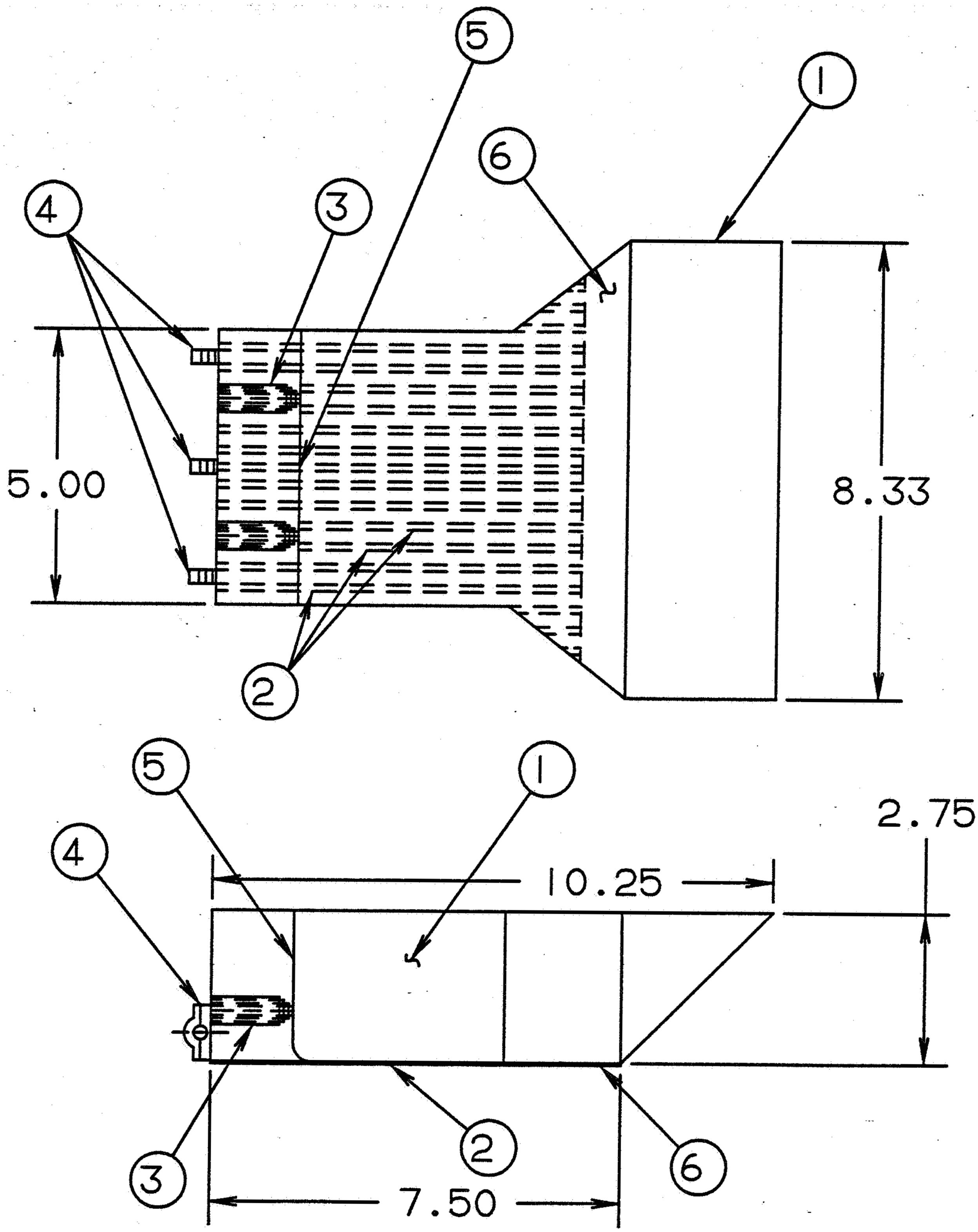


SUBSYSTEM: Scoop

ITEM#	QTY	DESCRIPTION	VENDOR	COST
1	1	.975 Cubic Yard Bucket		
2	17	Cutting Teeth	John Deere	
3	2	Mounting / Pivot Bracket		
4	2	Hydraulic Cylinder	Dukes WT 4048	
5	2	Extension Block		
6	35 ft	Al 2024 1/2" Wall 4"x4" Tubing		
7	2	Spacer		
8	4	1 1/4" x 12 UNF x 11" Bolt		
9	4	1 1/2" x 12 UNF x 8" Bolt		

The scoop subassembly is composed of a .975 cubic yard bucket that extends from the front of the vehicle on two 4″x4″ square Al 2024 tubes with a 1/2″ wall thickness. The scoop subassembly serves as an aid in filling the pan and it also is used to pull the entire vehicle out of a depression or over an obstacle up to 9 inches high. In its fully closed position the scoop is flush with the front of the pan. The bucket extends up to 5.6 feet in front of the vehicle from this position and rotates a maximum of 90 degrees. The maximum cutting depth is achieved at a bucket angle of 45 degrees relative to the closed position. The maximum depth of cut of the bucket is 6 inches. The approximate weight of the entire scoop subassembly is 600 pounds.

Pan Subassembly



SUBSYSTEM: PAN

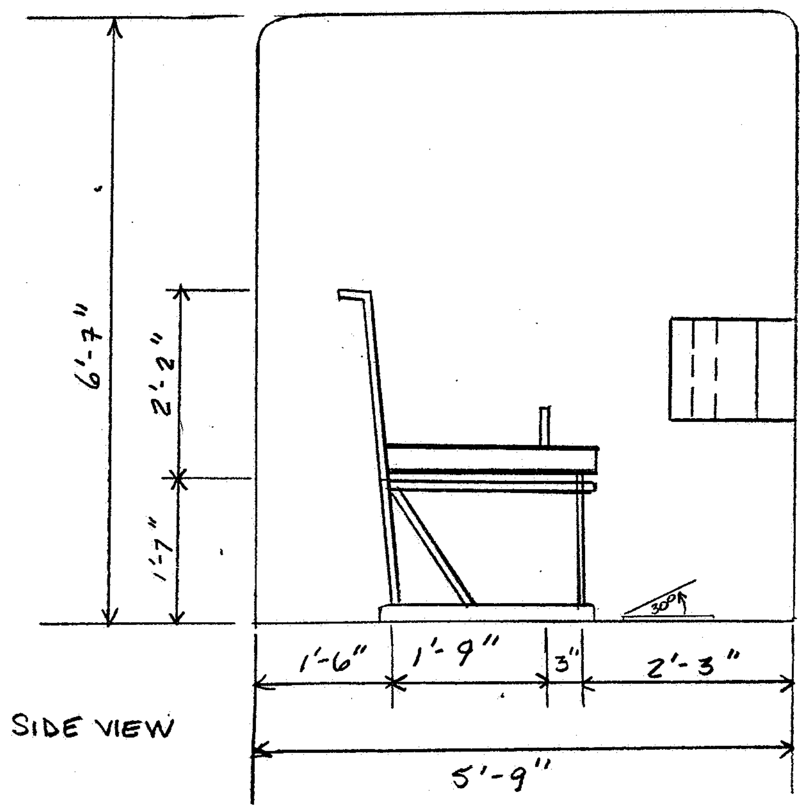
ITEM#	QTY	DESCRIPTION	VENDOR	COST
1	9	Al 2024 1/2" PLATE		
2	110 ft	Al 2024 1 1/2" x 1/2" Solid		
3	2	TELESCOPING CYLINDER		
4	3	Pillow Blocks		
5	1	Al 2024 1/2" PlATE (Push Wall)		
6	1	John DEERE GRADER EDGE	John DEERE	

The pan subassembly is the container for the transport of the lunar soil. The volume of the pan is 3.5 cubic yards. It is predominantly constructed of 1/2″ aluminum plate, welded to form the sides of the container. The base of the pan is 1″ plate reinforced with 1/2″ ribs. A standard cutting edge is being employed in the design.

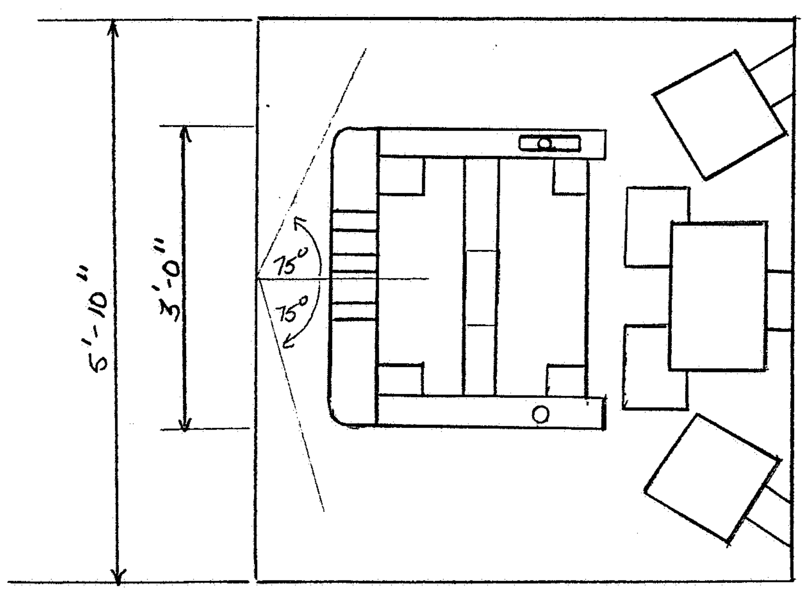
The pan is hinged at the rear of the subassembly. This location was chosen to minimize the tilt angle for a given cutting depth. A smaller tilt angle will ease the flow of the soil into the pan. The maximum cutting depth of the pan is 6 inches. This depth was chosen because of the traction and power limits that are obtainable in the lunar environment.

Emptying the pan is accomplished by pushing the movable rear wall forward while tipping the pan from horizontal.

Cab Subassembly



SIDE VIEW



TOP VIEW

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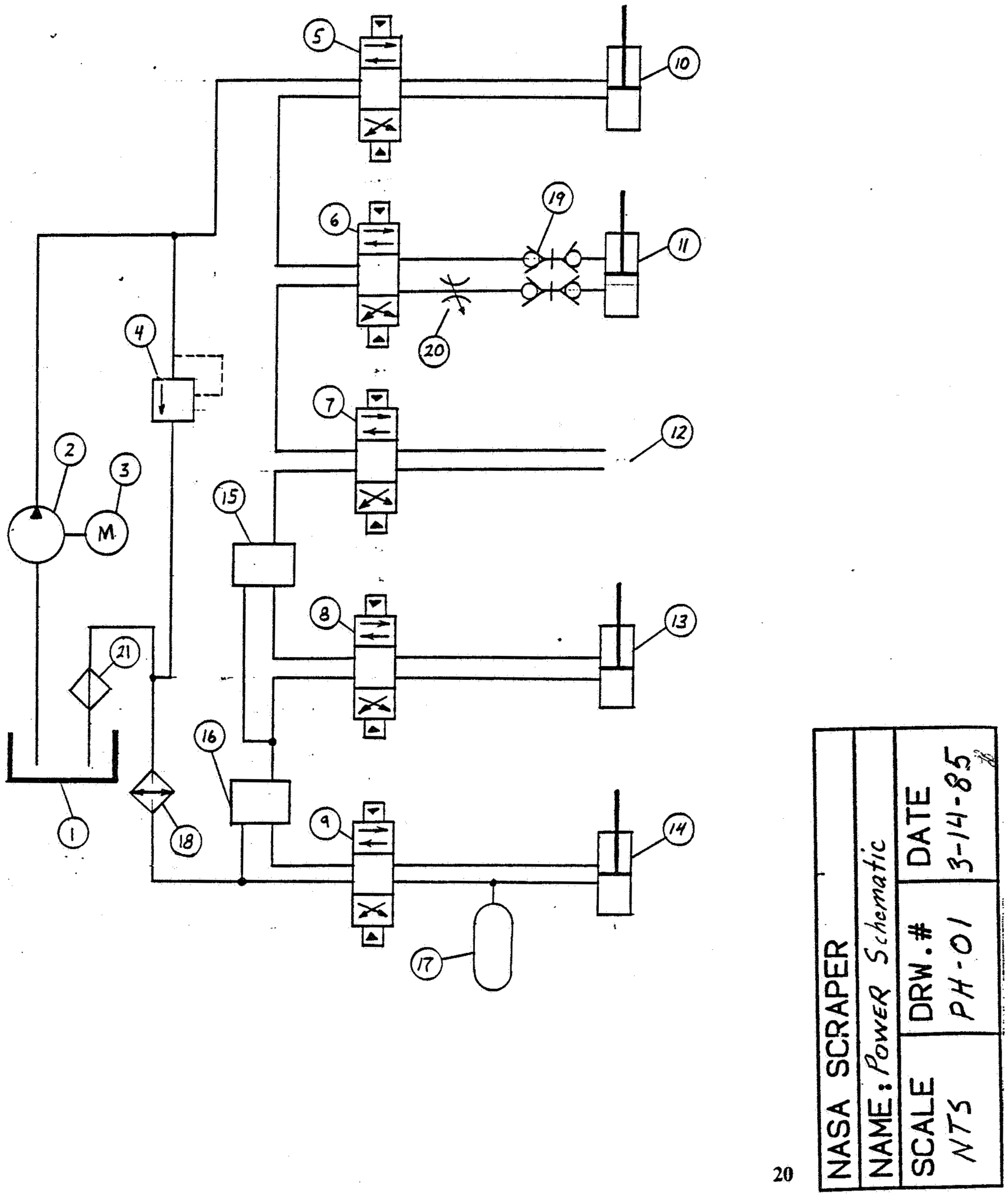
The Cab measuring 5′-10″ wide, 5′-9″ long, and 6′-7″ high is located on the front third portion of the main frame. Placement of this subsystem above the pan entrance provides protection to the operator from dust particles while still enabling him the full scope of vision of the scoop and its scraping movement. The cab consists of the operator's seat, the display and control consoles, hand control drive levers, and a protective roll bar (the later two of which are described more explicitly in their respective sections).

The floor panels and interior of the cab are constructed out of an aluminum alloy. One tubular aluminum seat is positioned in the cab center and rotates at an angle of 75 degrees from the normal allowing the operator ease of movement when getting into and out of the seat. The seat swivels to either side, the astronaut sits down, and it moves back to the normal position where it locks into place. Arm rests made of fiberglass are mounted on both sides to provide support for the arm while operating the hand controls. The seat is made of nylon webbing with attached velcro adjustment straps serving as a seat belt and restraint for the portable life support system (PLSS). The seat back is recessed and alleviates the astronaut by supporting the weight of the PLSS while sitting in the seat. There are two adjustable foot rests with toe holds that can be used in the up or down position. Three video monitors make up the display and control unit and are positioned in the very front of the cab. The display consoles are treated with a heat resistant paint and the other remaining components that make up the cab are coated with a heat resistant aluminum oxide for protection from the exposure to high temperatures.

Power / Hydraulics System



SUBSYSTEM: POWER / HYDRAULICS SYSTEM

ITEM#	QTY	DESCRIPTION	VENDOR	COST
1	1	Fluid Resevoir	manufactured	
2	1	Pump, Fixed displacement	Hydreco	
			1510 H	
3	1	Motor, D.C. Electric	Boston Gear	
			M327 TF-B	
4	1	Valve, Relief	Snap-tite	
			RDC-22	
5,6,7,8,9	1 each	Valve, 4 way 3 position	Dukes	
		tandem center	DV-120TD2HB	
10	2	Linear actuator, Scoop	Dukes	
			WT-4048	
11	2	Linear actuator, Bucket	Dukes	
			WT-4030	
12	2	Linear Actuator, Ram		
13	2	Linear Actuator, Pan	Dukes	
			WT-3012	
14	2	Linear actuator, Track	Dukes	
			WT-1506	
15	1	Valve, Relief	Snap-tite	
			RDC-22	
16	1	Valve Relief	Snap-tite	
			RDC-22	
17	2	Accumulator	EMG	
			AU 2520	
18	1	Heat Exchanger	manufactured	
		12 000 BTU/hr		
19	1	Coupling, Quick Disconnect	Snaptite	
		with checks	29N12-56	
			29N12-49	
20		Valve deceleration		
21	1	Filter	Schroeder	
			RT-1KM10	

We shall begin the calculations based on a single 8 HP DC electric motor.

Our choice will be: RATIOTROL M327TF-B

A suitable line pressure of 1000 psi is dictated to reduce hydraulic cylinder leakages to roughly 4 in per minute. Our choice of pump is the Hydreco 1510C1B1. This pump coupled to the above motor shall produce 8 GPM at 1200 psi line pressure. Suitable downrating shall produce approximately 8 GPM at 1000 psi line pressure. These conditions shall provide our constraints. Wherever possible, the hydraulic cylinder will be operated in tension. This will reduce the available fôrce by roughly 50%, but this will eliminate any buckling tendencies.

SUBSYSTEMS

1.) Scoop: 8 GPM total available at 1000 psi line pressure.

The scoop shall add to the effective drawbar pull available. A nominal stroke of 4 feet is desired as well as a large piston area.

A suitable choice is the DUKES Series WT-4048.

This is a dual acting cylinder with a 4 in. bore, 2.5 in piston, and a 48 in. stroke. This cylinder provides an effective tensil loading area of 7.69 in . Two cylinders acting in parallel would provide 15.38 in . Using an available line pressure of 1000 psi would provide a 15,300 lbf scraping action. This force, along with a driven drawbar pull of 2000 lbf is equivalent to 17,300 lbf. This force is comparable to medium sized earth bound handling equipement. Furthermore, typical lunar soil is modeled as wet sand having low shear requirements. Thus, we believe that adaquate power is available to pick up lunar top soil.

Scoop System engagement speeds are as follows.

$$\text{retract}: \quad \frac{48\ \text{IN}}{120\ \text{IN/MIN}} = 0.40\ \text{MIN}$$

$$\text{extend}: \quad \frac{48\ \text{IN}}{72\ \text{IN/MIN}} = 0.67\ \text{MIN}$$

This design allows negligible compressive forces to be placed on the cylinder piston while extending the scoop subsystem.

2.) Bucket: 8 GPM available at 1000 psi line pressure.

The bucket hydraulics shall position the blade to the required depth of cut. A nominal stroke of 25 in. is necessary as well as a large piston assembly.

A suitable choice is the DUKES Series WT-4030.

This is a dual acting cylinder with a 4 in. bore, a 2.5 in. piston, and a 30 in. stroke. This cylinder provides a compressive area of 12.6 in . Two cylinders acting in parallel will provide 25.2 in . Using the 1000 psi line pressure available, this system would provide 25,200 lbf. The cylinder will be extended 8 in. when the bucket is at its outermost position to aid in achieving a favorable mechanical advantage at its maximum cutting depth. The buckets' hydraulics operate on a lever arm principle. The transmitted force at the blade edge is

$$25{,}200\ \text{lb} \times \left(\frac{1.48\ \text{ft}}{4.26\ \text{ft}} \right) = 8700\ \text{lb}_f$$

at a maximum cut of 6 in. depth. Since this pressure is required for a relatively short time, no accumulator is planned.

Bucket travel speeds:

$$\text{extend}: \frac{25\ IN}{120\ \frac{IN}{MIN}} = 0.21\ MIN \qquad \text{retract}: \frac{25\ IN}{72\ \frac{IN}{MIN}} = 0.35\ MIN$$

3.) Pan: 8 GPM available at 1000 psi line pressure.

The pan hydraulics shall act to lower or raise the pan to the desired depth of cut or to raise the pan while trasporting soil.

A nominal stroke of 9 in. is necessary, but a smaller piston assembly is allowable. Allowing for a 3 yd capacity and a soil density of 2.5 g/cm , total soil mass will be 2100 lunar pounds. The mass of the pan is estimated to be 300 lunar pounds, thus a total of 2400 pounds will be raised or lowered. The center of gravity of a full pan is approximately 5.2 ft. from the hinge point. The cylinder will act at this point. Our constraint shall be to lift a weight of 2400 lunar pounds a distance of 9 in.

We shall choose a DUKE Series WT-3012.

This is a dual acting cylinder with a 3 in. bore, a 1.25 in. piston, and a 12 in. stroke. This cylinder provides a tensil area of 5.84 in . Two cylinders in parallel provide an area of 11.68 in . A line pressure of 1000 psi shall offer a force of 11,600 lbf. Since our minimum requirement is 2,400 lbf, a safty factor of 4.8 is acheived. A flow limiter of 2 GPM per cylinder is required to gently position the pan at the desired cutting depth.

Travel speeds for 2 GPM are:

$$\text{up}: \frac{9.0\ IN}{80\ \frac{IN}{MIN}} = 0.11\ MIN$$

$$\text{down}: \frac{9.0\ IN}{65\ \frac{IN}{MIN}} = 0.14\ MIN$$

4.) Ram: 8 GPM total available at 1000 psi line pressure.

The ram hydraulics shall be used to push out collected soil from within the pan. Weight of soil is 2100 lunar pounds and estimating the coefficient of friction at 0.2, required force shall be 420 lbf. Since two rams are being used, each shall have to deliver 210 lbf.

Due to a short compressed length and long extended length a dual acting telescoping cylinder must be used.

5.) Track: 8 GPM total available at 1000 psi line pressure.

The track hydraulics shall serve to move the idler wheel in order to tighten the track. This will also facilitate repairs or maintenance as required.

A nominal stroke of 6 in. is necessary and smaller piston cylinder assembly is allowable. Each cylinder may act independantly of the other. It is estimated that a force of 500 lbf will be required to accomplish this task.

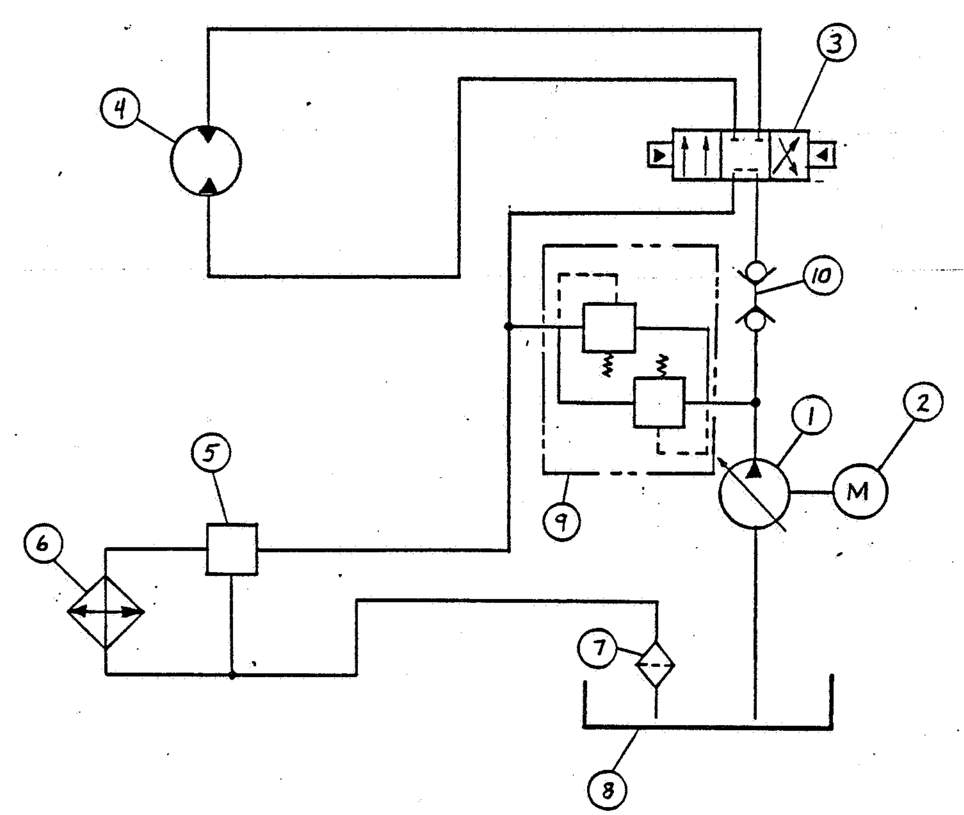
A suitable choice is the DUKES Series WFC-1506 dual acting cylinder with a 1.5 in bore, a .63 in. piston, and a 6 in. stroke.

This cylinder provides a compressive area of 1.77 in . A line pressure of 1000 psi will allow a force of 1700 lbf. Since the estimated force required is 500 lbf, a factor of safty of 3.4 is acheived.

Since this force will be held for long periods of time, an accumulator will be required.

The flow rate must be lowered to 0.1 GPM to achieve gentle tightening of the track system. This metering would provide a 0.22 inch per second positioning rate. Furthermore, an adjustable relief valve should be used to fine tune the actual force necessary.

An alternate design would include a spring and threaded rod-nut assembly, however this alternative would prove difficult to use in the adverse lunar conditions.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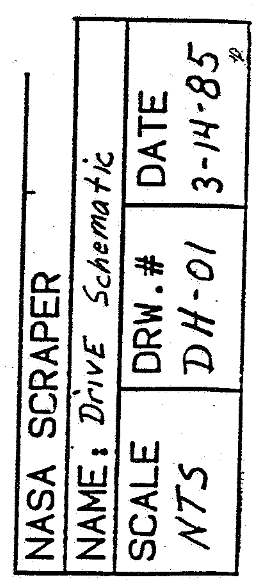
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NAME: Drive Schematic
SCALE NTS
DRW. # DH-01
DATE 3-14-85

SUBSYSTEM: DRIVE SYSTEM POWER /HYDRAULICS

ITEM#	QTY	DESCRIPTION	VENDOR	COST
1	2	Pump, Variable displacement	Rexroth	
			1PV2V4-10/50R	DM160A1
2	2	Motor, D.C. Electric	Boston Gear	
			M3210 T/TN	
3	2	Valve, 4 way - 3 position	Dukes	
		tandem center	DV-120TD1HB	
4	2	Motor, hydraulic drive	Rexroth	
			CH(B)300/430	
5	2	Valve	Brand	
			FG528	
6	2	Heat Exchanger	manufactured	
		40,000 BTU/hr		
7	2	Filter	Schroeder	
			RT-1KM10	
8	1	Fluid resevoir	manufactured	
9	2	Valve, relief	Snap-tite	
			MDD-22	
10	2	Coupling, Quick Disconnect	Snap-tite	
		with checks	29N12-56	
			29N12-49	

Calculation of power requirements.

Total Tractive Effort - T.E.

T.E. = RR + GR + FA + DP

A.) Rolling Resistance - RR

$$RR = \frac{GVW}{1000} \times R$$

R = 150 lbs

$$RR_{EMPTY} = \frac{1500}{1000} \times 150\ lb_f = 225\ lb_f$$

$$RR_{FULL} = \frac{3600}{1000} \times 150\ lb_f = 540\ lb_f$$

B.) Grade Resistance - GR

$$GR = \frac{\%\ Grade}{100} \times GVW$$

14 degree slope = 25% Grade

$$GR_{EMPTY} = \frac{25\%}{1000} \times 1500 = 375_f$$

$$GR_{FULL} = \frac{25\%}{1000} \times 3600 = 900\ lb_f$$

C.) Acceleration Force - FA

$$FA = \frac{MPH \times GVW}{22t}$$

$$= \frac{10\ MPH \times 3600}{22\,(10\,sec)} = 160\ lb_f$$

D.) Estimate Drawbar Pull - DP

DP = 2000 lbs

E.) T.E. = RR + GR + FA + DP

Evaluate All Possibilities

1. Empty
2. Empty + 25% grade
3. Empty + 25% grade + drawing
4. Empty + drawing
5. Full
6. Full + 25% grade
7. Almost full + 25% grade + drawing
8. Almost full + drawing

Power requirements will be as follows:

1.	225	+		+	50			=	275
2.	225	+	375	+	50			=	670
3.	225	+	375	+	50	+	2000	=	2670
4.	225				50	+	2000	=	2755
5.	540			+	160			=	700
6.	540	+	900	+	160			=	1600
7.	540	+	900	+	160	+	2000	=	3600
8.	540	+			160	+	2000	=	2700

thus, the force requirements are:

1. 275 lbs
2. 670 lbs
3. 2670 lbs
4. 2275 lbs
5. 700 lbs
6. 1600 lbs
7. 3600 lbs
8. 2700 lbs

total

F.) Calculate Hydraulic Motor Torque

$$T = \frac{TE \times r}{N \times G}$$

- r = wheel radius
- N = # of drive motors
- G = effective gear reduction.

Through trial and error, as well as trade-offs, we shall use the following.

We believe that acheivement of possibilities 1, 2, 5, 6 are imperative. Other possibilities will be met through the use of the scraper, or can not be met with reasonable power considerations.

Choice of hydraulic drive motor.

Rexroth/Carron wheel hub, rotating case motor.

- Part number CH(B)300/430
- Displacement 26.2 in /rev
- Torque Output = 348 lb.ft/1000 psi * operating pressure
- Maximum Speed = 400 rpm

The most strenuous constraint is 1600 lbs

The least strenuous constraint is 385 lbs

1600 lbs constraint:

$$T = \frac{1600\,lb \times 1.0\,ft}{2\,motors \times 1.0} = 800\ ft \cdot lb_f$$

Operating pressure can now be determined:

$$O.P. = \frac{800\ ft \cdot lb \times 1000\ psi}{348\ lb \cdot ft} = 2300\ psi$$

385 lbs constraint:

$$T = \frac{385\ lb \times 1.0\ ft}{2\ motors \times 1.0} = 192\ ft \cdot lb_f$$

Operating pressure can now be determined:

$$O.P. = \frac{192\ ft \cdot lb \times 1000\ psi}{348\ lb \cdot ft} = 550\ psi$$

thus, operating pressure shall nominally range from 550 psi to 2300 psi.

A suitable multiplication factor of 1.20 is required to take care of pressure losses in piping, flow control valves and other pumping losses. Thus, needed pressure will range from 660 psi to 2760 psi.

We now need to calculate the flow rate equivalent to achieve a 10 mph cruise.

$$rpm = \frac{168 \times mph}{r_{INCHES}} = \frac{168 \times 10\ mph}{12\ IN} = 140\ rpm's$$

$$\text{flow rate}: \quad 140\ \frac{rev}{min} \times \frac{26.2\ IN^3}{rev}\ \frac{1\ GAL}{231\ IN^3} = 16\ \frac{GAL}{MIN}\ @\ 660\ psi$$

A suitable pump must now be chosen. We have chosen a Rexroth 1PV2V4-10/50RDM160A1. This pump would be modified to achieve 2800 psi safely. It's present form will handle 2400 psi safely.

ELECTRICAL POWER REQUIREMENTS:

using the following formula,

$$HP = \frac{GPM \times psi}{1714 \times \eta}$$

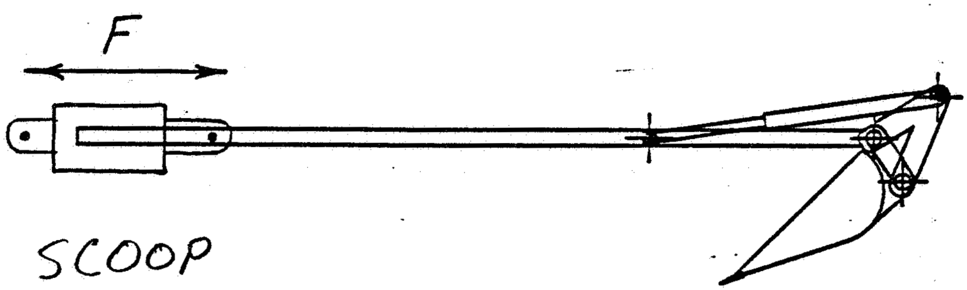
typical efficiency is roughly 85%, thus

$$HP = \frac{16\ GPM \times 660\ psi}{1714 \times 0.85} = 7.3\ H.P.$$

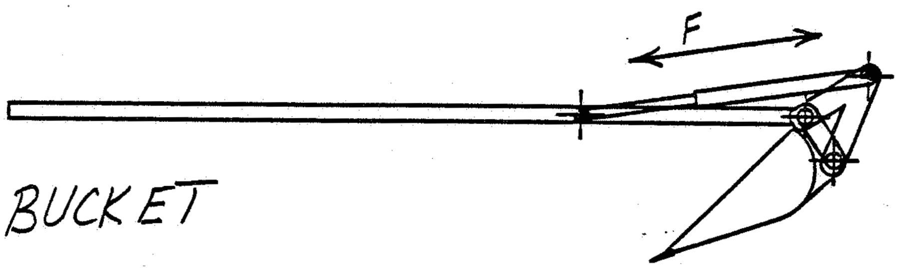
For an additional margin of safety, a 10 HP. D.C. electric motor shall be chosen. The part number is RATIOTROL M3 2 10 T/TN.

The previously mentioned hydraulic hub motor, hydraulic pump, and electric motor shall be used in pairs; one pair for each of two track systems.

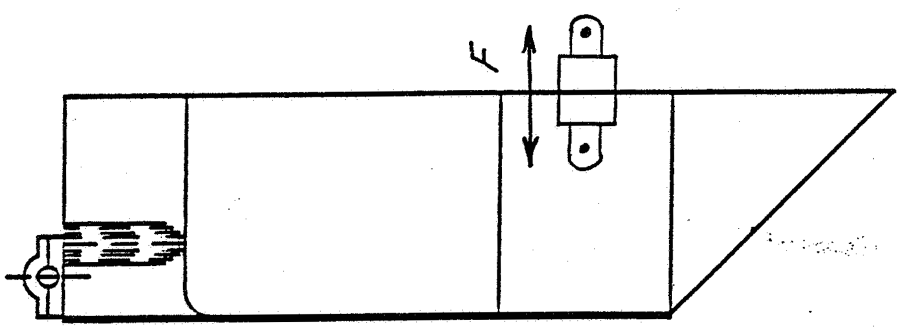
CYLINDER PLACEMENTS



SCOOP

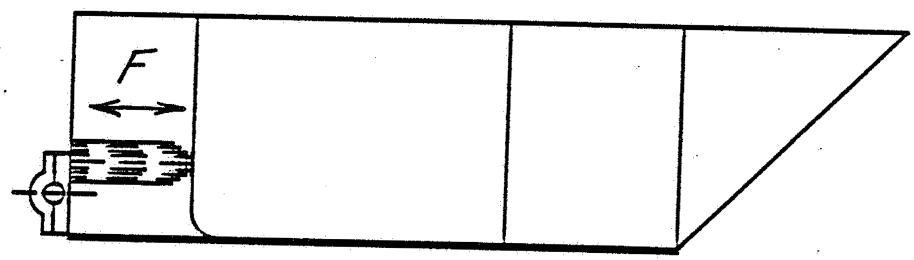


BUCKET

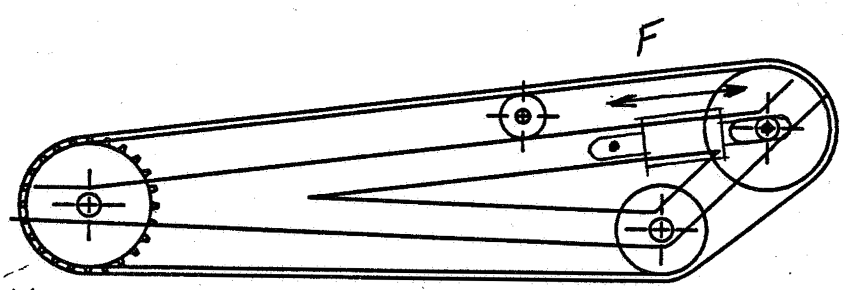


PAN

CYLINDER PLACEMENTS

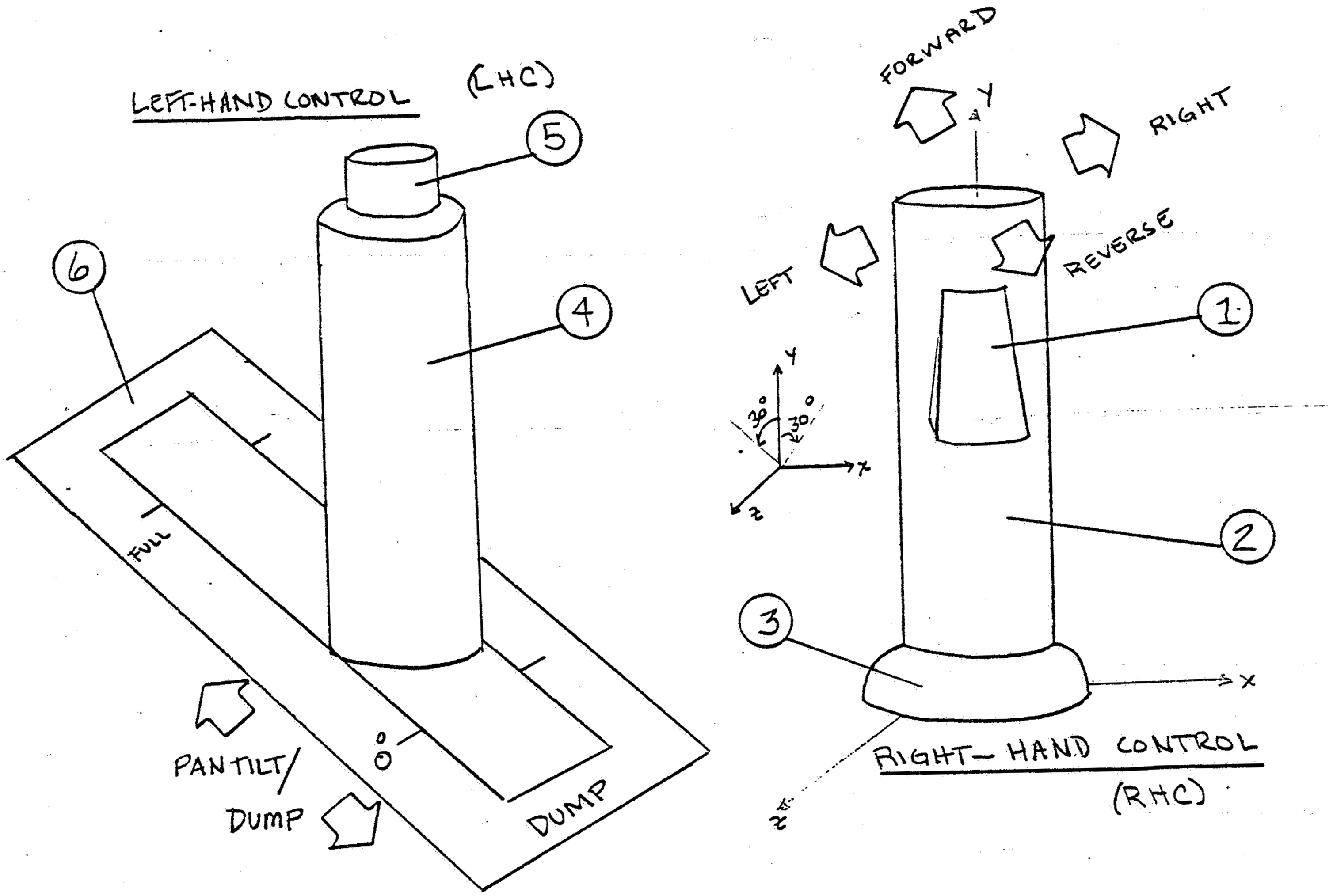


RAM



TRACK

Drive Controls



The drive control system should be in a "fly by wire" arrangement. This adds to the PAN systems versatility by allowing for remote control operation and simultaneous operation of several pieces of equipment. The PAN should be continuosly monitored by an on-board computer system to ensure proper vehicle operation. In the case of a system malfunction or an attempt to excede a design specification, a low power FM radio warning should be transmitted to the operator. A selective manual overide should be available in case of a computer malfunction or a specific need to attempt to exceed normal design specifications. However , if no response to the computer warning is made, then the system should engage an immediate and safe system shutdown. The display system should show all pertinent operation information on the centrally located monitor. In addition, this information should be relayed via radio telemetry for remote control operation. The video monitor should display such data as: pan angle , drive motor load , % pan capacity used , hydraulic and motor temperatures , speed , vehicle grade angle , power consumed , time until 'empty' at present consumption rate , etc. The use of bar graphs in addition to numerical data is recommended due to the difficulty of quickly interpreting digital data alone. The display monitors should have integral sun screens to prevent excessive washout in direct sunlight. The front panel switches and circuit breakers should be conveniently located under the central monitor and be of the same type as used on the space shuttle. The two additional monitors in the cab are to aid the operator in situation where he needs to see the extreme front or rear of the vehicle. The monitor on the left side of the cab would normally be used to show the rear of the pan, but can be switched to show video from other camera locations. The monitor on the right side of the cab is normally used only as a backup in case one of the other monitors fails , but it can be used to display an additional camera view for difficult situations such as parking the pan or maneuvering in other tight situations.

HAND CONTROLS

Right Hand Control. Pull stick back to engage parking brake and release by pushing the stick to the right. Engage reverse by pulling the stick to center position, flip down the reverse switch, and pull the stick backwards. The reverse switch automatically engages the monitor to display the rear view. Turning to the left or right is effected by the corresponding movement of the joystick.

Left Hand Control. The scrape angle is set by movement of the ratcheted slide left hand control. By pulling to the full rear (past zero) the pan is automatically emptied. The scoop is extended when the button is pressed down. The bucket angle is selected in conjunction with the pan tilt/ scrape angle if the scoop is fully extended. If the scoop is not fully extended then it remains tilted up so the pan can be used in a conventional manner.

Thermal Control Systems

The hydraulic pump motors are housed inside the fluid storage tank. These motors assist in maintaining the hydraulic fluid at the proper working temperature. When the hydraulic fluid approaches the maximum allowable operating temperature a switchable radiative heat sink should be employed. By using electronic solenoid valves,the radiators can be selectively employed (one , both , or bypass should one unit fail) The radiators should be similar in design and operation to those used on the original lunar roving vehicle. They are particularly well suited for placement on the fenders of the track drive assembly. The radiators should have removable covers to protect them from dust accumulation and damage during normal operation. These covers should be able to be opened manually or automatically for cooldown after operation of the pan. The covers should close automatically when the lower operating temperature is reached. This can be accomplished by using bimetallic springs which are thermally activated. The heat generated by the drive system motors is more difficult to control. The best method to remove this heat is to incorporate the use of thermal straps and fusible mass heat sinks (as was used to thermally control some parts of the lunar rover). These fusible mass heat sinks should be located with the battery/fuel cell power supply so as not to waste the heat. The fusible mass heat sinks should also be located next to the hydraulic fluid storage tank. This way the power supply , fusible mass sinks , and the hydraulic fluid can be simultaneously maintained at proper operating temperature , and still keep cooling capacity for any or all of the units should they need it. The electronic subsytems also need to have thermal control devices. The cental processing unit, display systems, and other heat generating components can be attached to fusible mass heat sinks via thermal straps. The drive control /display electronics subsystems should have a seperate battery system to isolate them from the motor power units. Therefore, the fusible mass heat sinks should be located so that they can dump some of their excess heat to maintain proper battery temperature. However, with the advent of low power electronic circuitry since the era of the lunar rover, it should not be necessary to include the drive control electronics in the main radiator system.

Passive thermal protection must not be neglected either. Consideration must not only be given for heat management during operation, but also during boost, orbit, translunar flight, landing and intermittant storage while on the moon.

Normallly these problems can be easily overcome by strategic use of reflective aluminized mylar, fiberglass type insulation and special surface finish anodization and paints).

Conclusions

The design of the cab and its components is based primarily on the contributing human factors. All sizing of the seat, the height of the cab, placement of hand controls & foot rests, and the location and arrangement of video monitors were done with the astronaut in mind.Zones of comfort and reach served as primary aids in deciding where each cab assembly unit was to be placed in relation to each other. To the best of one's knowledge, the cab as it stands at present would be comfortable enough for someone dressed in a spacesuit to move around and adequately operate the controls. Heat dissipation will prove to be one of the worst problems encountered that would effect the vehicle as a whole. To avoid problems with specific members of the machine, a cool down period will be required between uses of the vehicle. The power requirements for a vehicle of this magnitude will require state of the art in battery technology. It is assured that battery packs that are easily replaceable will be required. Tracks were chosen over conventional wheels because of the added traction obtained. Two idlers are staggered in the front of the track to increase the rolling radius of the vehicle. This design will allow the vehicle to maneuver over large obstacles with less difficulty. Even though titanium is very expensive, tracks designed with this material are considerably lighter than an equivalent strength steel, and are more wear resistant than aluminum.

Appendix A.

Calculations

TRACK LENGTH

If the torque required to slip the wheel (TS) is less than the hydraulic motor torque (T) then the performance objectives cannot be achieved. Actually it may be desirable that the track slip when excessive loads are imposed to prevent hydraulic system overheating if the vehicle becomes stalled. In this case TS should be slightly larger than T.

When calculating TS above, a wheel radius of one foot was used. Actually the equivalent r value for the tracks will be larger than one. The tracks have 8.25 feet of contact surface, and a wheel with a two foot diameter will have approxiamately .79 feet of contact surface. This gives us a factor of safety of 10.44. Therefore, the tracks provide the required torque needed to move the vehicle.

$$TS = \frac{Wfr}{G}$$

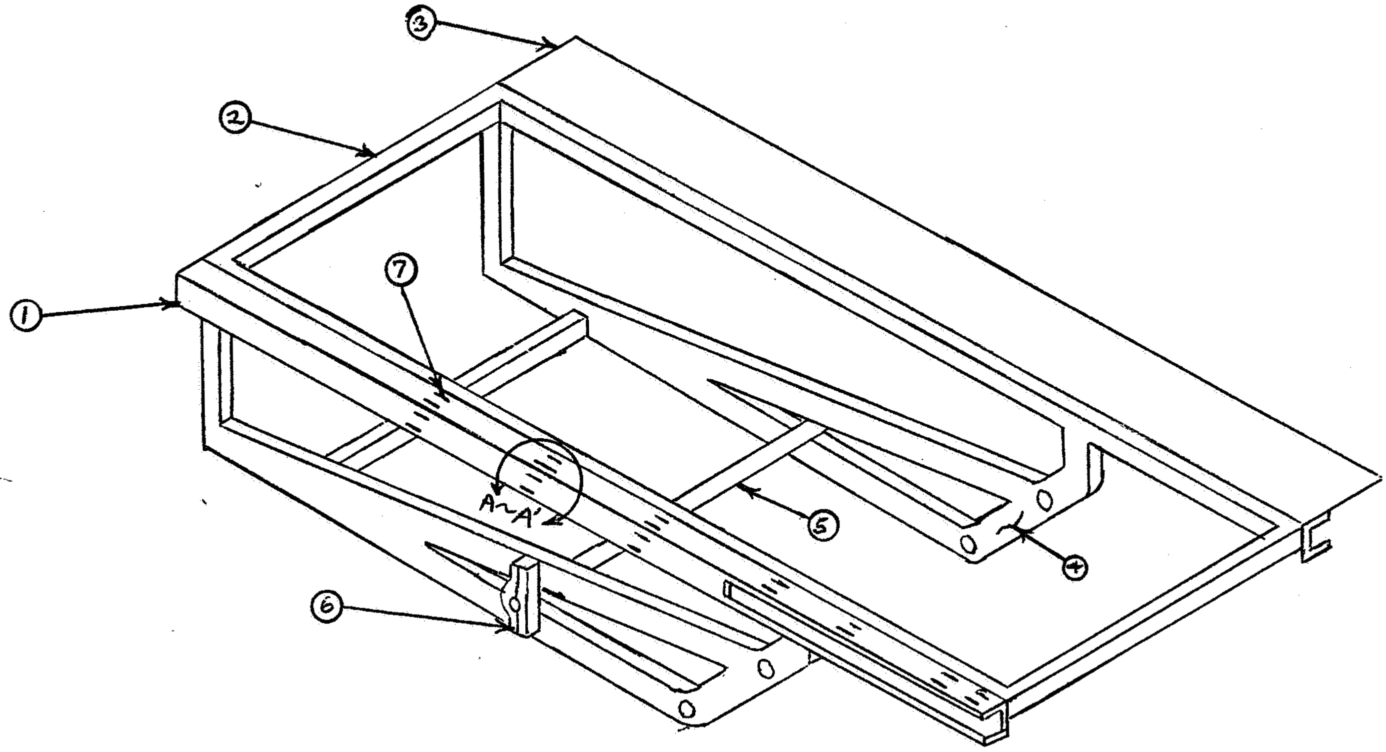
$$TS = \frac{(3600)(.6)(1)}{1}$$

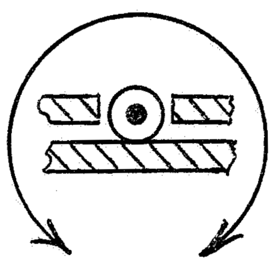
$$\underline{TS = 2160 \text{ ft}\cdot\text{lb}}$$

$$TS > T$$

W = loaded vehicle weight
r = wheel radius
G = gear ratio
f = coefficient of friction

Drawings

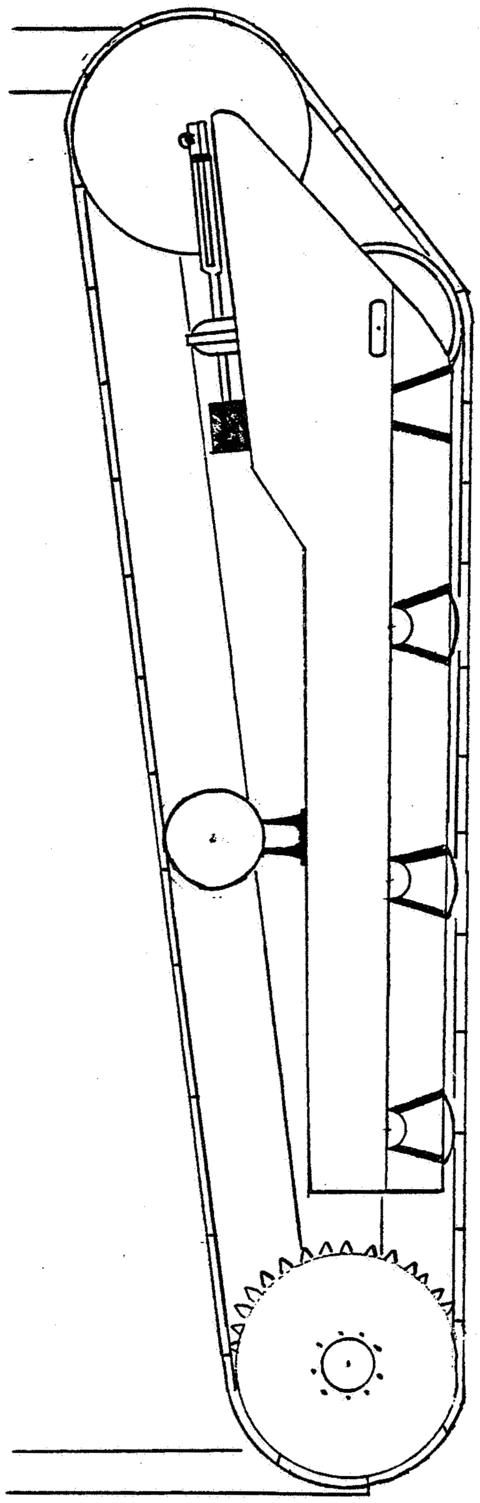




SECTION A~A'

NASA SCRAPER		
NAME: FA		
SCALE	DRW. #	DATE
N/A	02	3/14/85

Track Subassembly

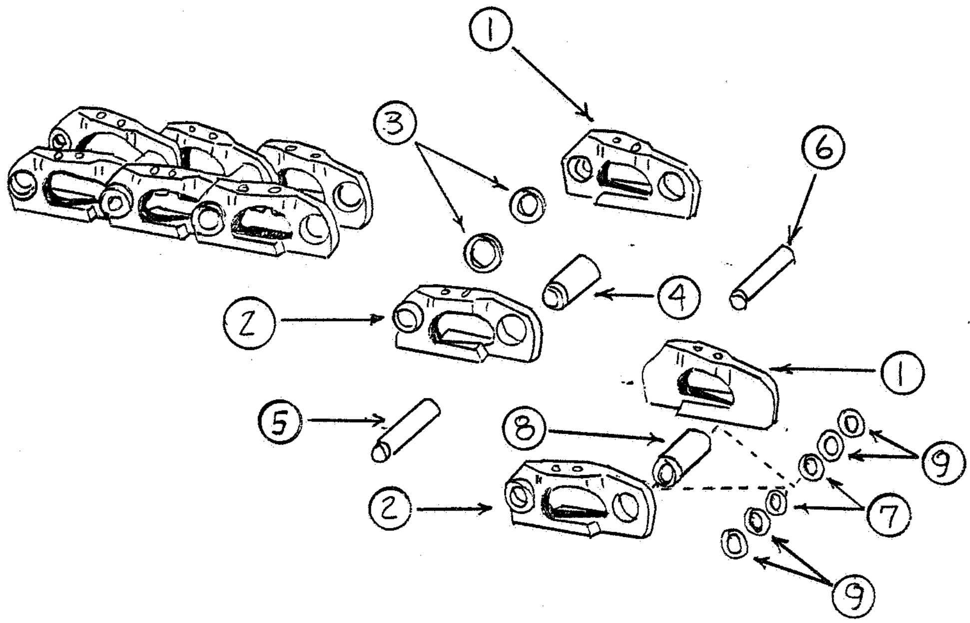


NASA SCRAPER

NAME: Track

SCALE | DRW.# T-1 | DATE 3/14

TRACK CHAIN

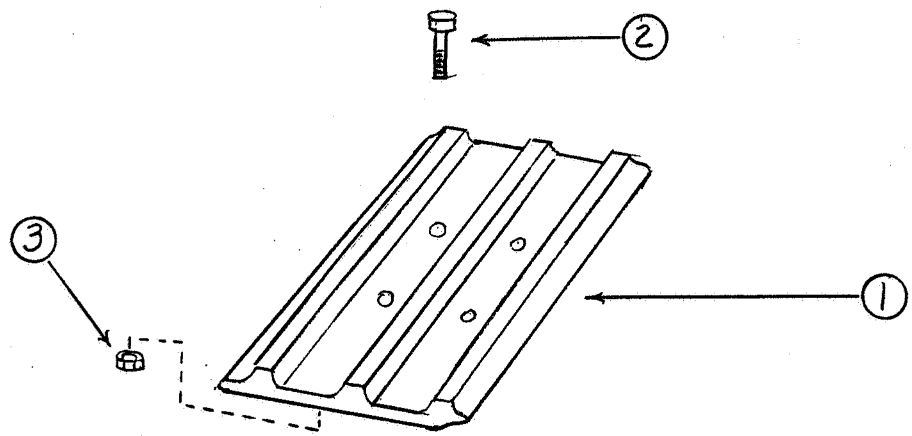


NASA SCRAPER		
NAME: Track Chain		
SCALE	DRW. # T-2	DATE 3/14

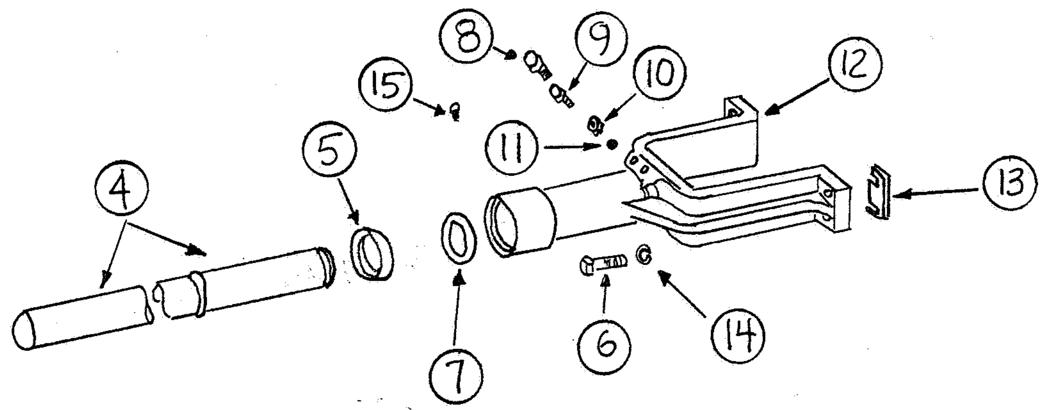
SUBSYSTEM: Track chain

ITEM#	QTY	DESCRIPTION	VENDOR	COST
1	1	track link (Rt. 35/track)		
2	1	track link (lt. 35/track)		
3	2	Washer		
4	1	Bushing (34/track)		
5	1	Dowel pin (34/track)		
6	1	Pin		
7	2	Washer		
8	1	Bushing		
9	140	Washer		

TRACK SHOES



HYDRAULIC TRACK TENSION ADJUSTER

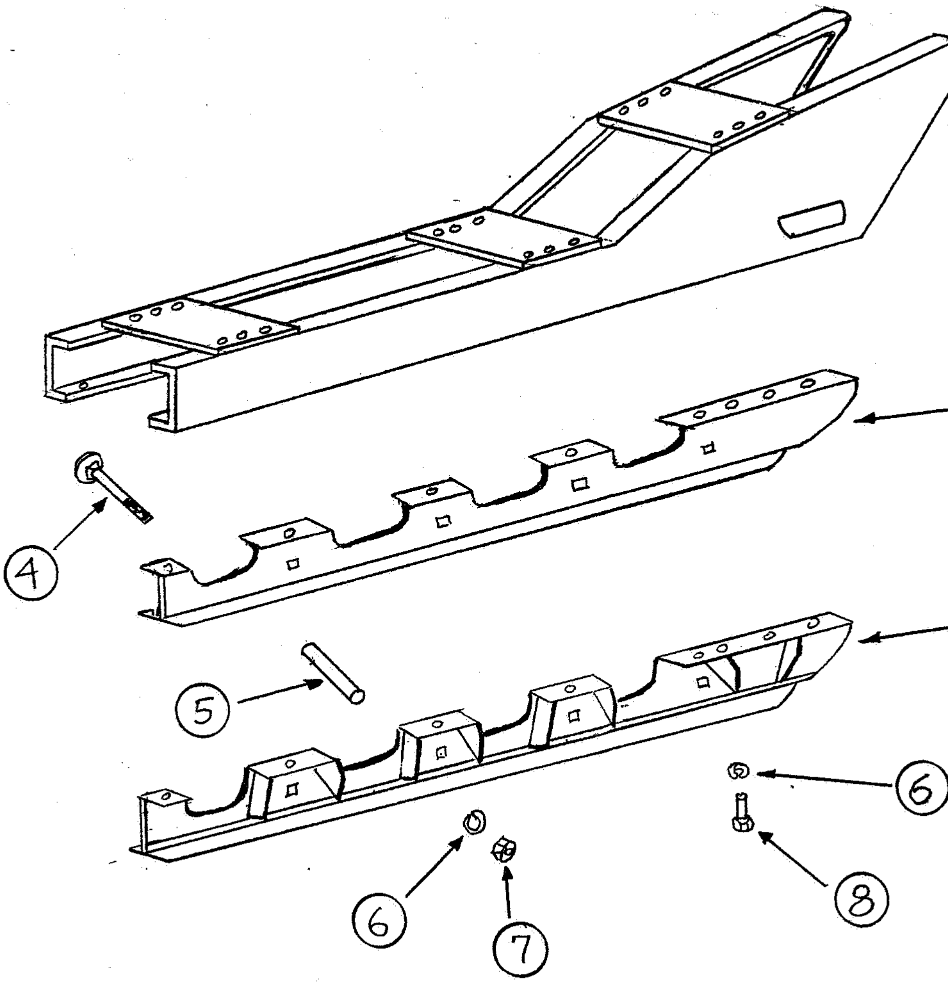


NASA SCRAPER		
NAME: Track Shoes		
SCALE	DRW. # T-3	DATE 3/14

SUBSYSTEM: Track Shoes & Hydraulic Tension Adjuster

ITEM#	QTY	DESCRIPTION	VENDOR	COST
1	1	Single bar Shoe (35/track)		
2	1	Bolt (4/shoe)		
3	1	Hex nut (4/shoe)		
4	1	Piston		
5	1	Seal		
6	4	Cap Screw		
7	1	Seal		
8	1	Lubrication fitting		
9	1	Set screw		
10	1	Nut		
11	1	Ball		
12	1	Yoke		
13	6	Strap		
14	4	Lock Washer		
15	1	Lubrication Fitting		

Loader Track Frame

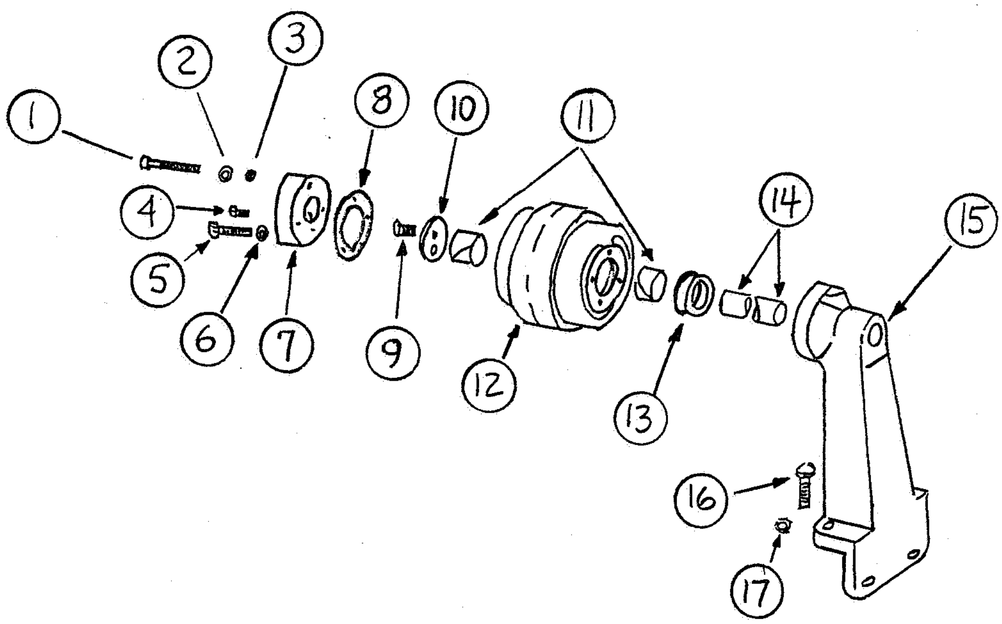


NASA SCRAPER		
NAME: Loader Track Frame		
SCALE	DRW. # T-4	DATE 3/14

SUBSYSTEM: LOADER TRACK FRAME

ITEM#	QTY	DESCRIPTION	VENDOR	COST
1	1	FRAME		
2	1	Guard (inside)		
3	1	Guard (outside)		
4	1	Bolt (4/side)		
5	1	Bushing (4/side)		
6	30	Lock washer		
7	8	Nut		
8	8	Cap Screw		

Upper Track Carrier Roller

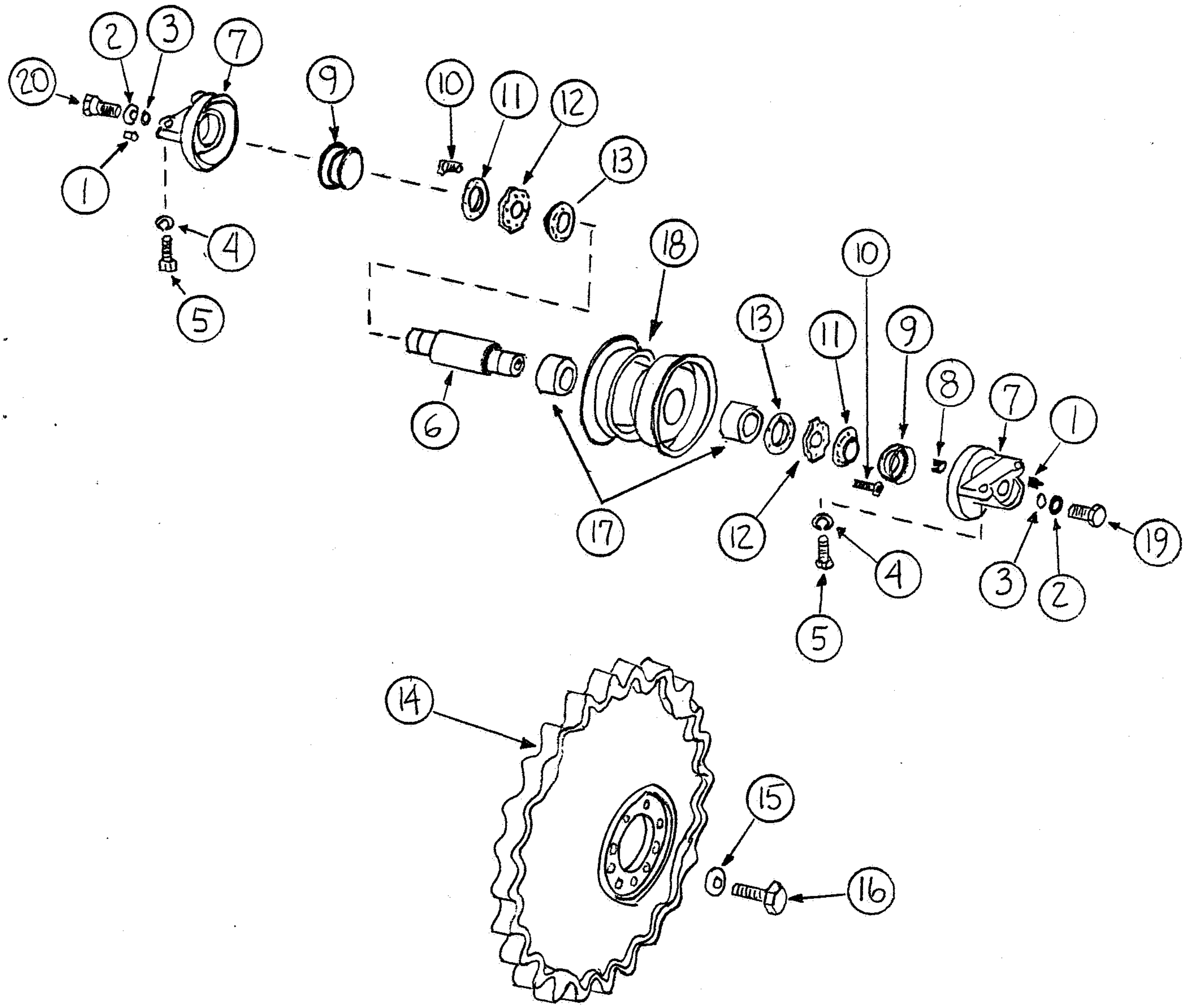


NASA SCRAPER		
NAME: Carrier Roller		
SCALE	DRW. # T-5	DATE 3/14

SUBSYSTEM: Upper track Carrier roller

ITEM#	QTY	DESCRIPTION	VENDOR	COST
1	1	Cap screw 3/8" x 1-3/4"		
2	1	Washer 13/32" x 11/16" x .06"		
3	1	Gasket		
4	1	Pipe Plug		
5	2	Cap Screw 3/8" x 1-1/8"		
6	2	Lock Washer 3/8"		
7	1	Cover		
8	1	Gasket		
9	2	Screw Socket head		
10	1	Plate		
11	2	Bushing		
12	1	Roller		
13	1	Seal Kit		
14	1	Shaft		
15	1	Support		
16	4	Cap Screw		
17	4	Lock washer		

TRACK ROLLER & SPROCKET

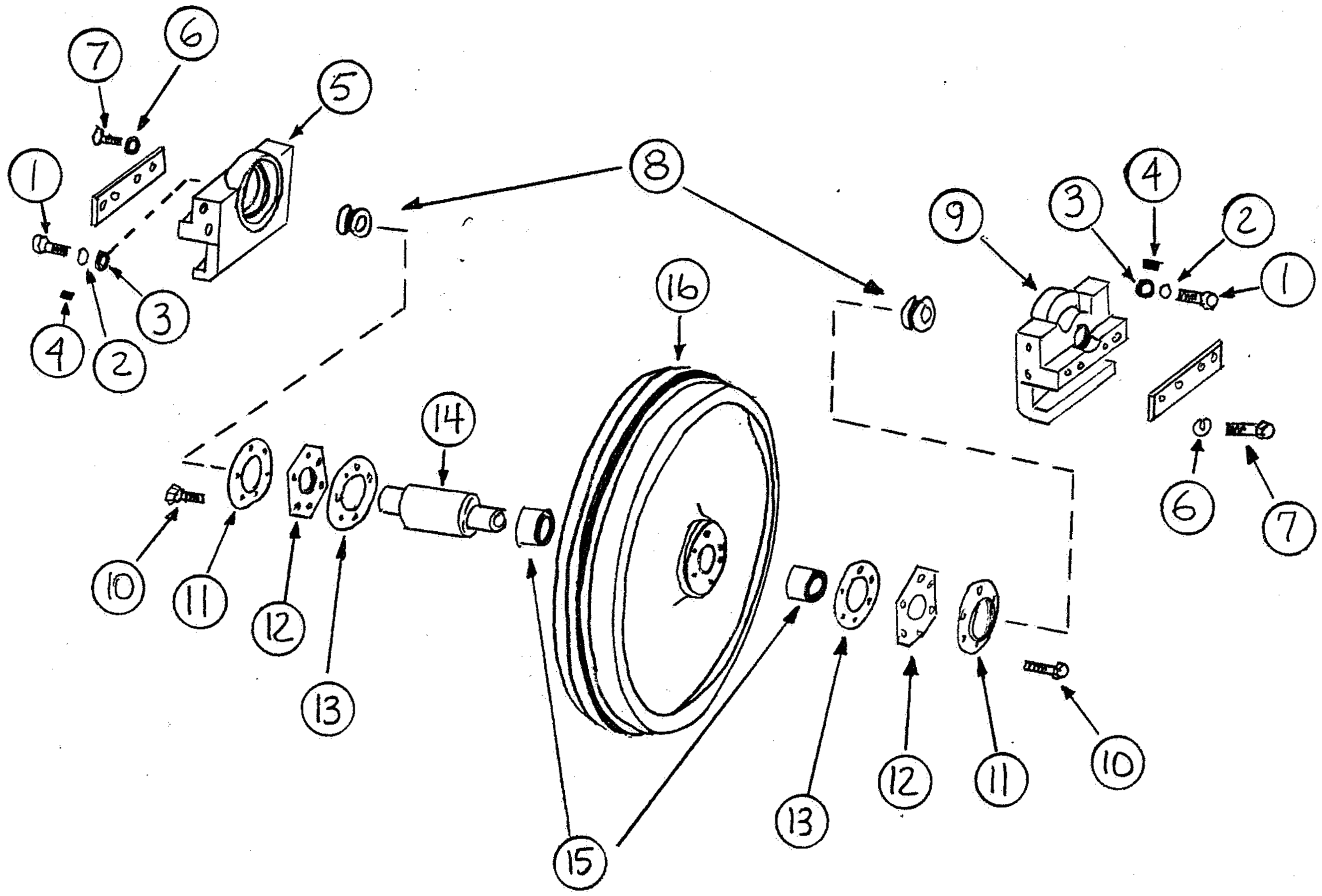


NASA SCRAPER		
NAME: Track Roller & Sprock[et]		
SCALE	DRW. # T-6	DATE 3/14

SUBSYSTEM: Track Roller & Sprocket

ITEM#	QTY	DESCRIPTION	VENDOR	COST
1	3	Pipe Plug		
2	2	Washer		
3	2	O-Ring		
4	4	Lock Washer		
5	4	Cap Screw		
6	1	Shaft		
7	2	Bracket		
8	1	Dowel Pin		
9	2	Seal Kit		
10	12	Screw		
11	2	Ring		
12	2	Plate		
13	2	Gasket		
14	1	Chain Sprocket		
15	9	Washer		
16	9	Cap Screw		
17	2	Bushing		
18	1	Roller		
19	1	Cap Screw		
20	1	Cap Screw		

TRACK IDLERS

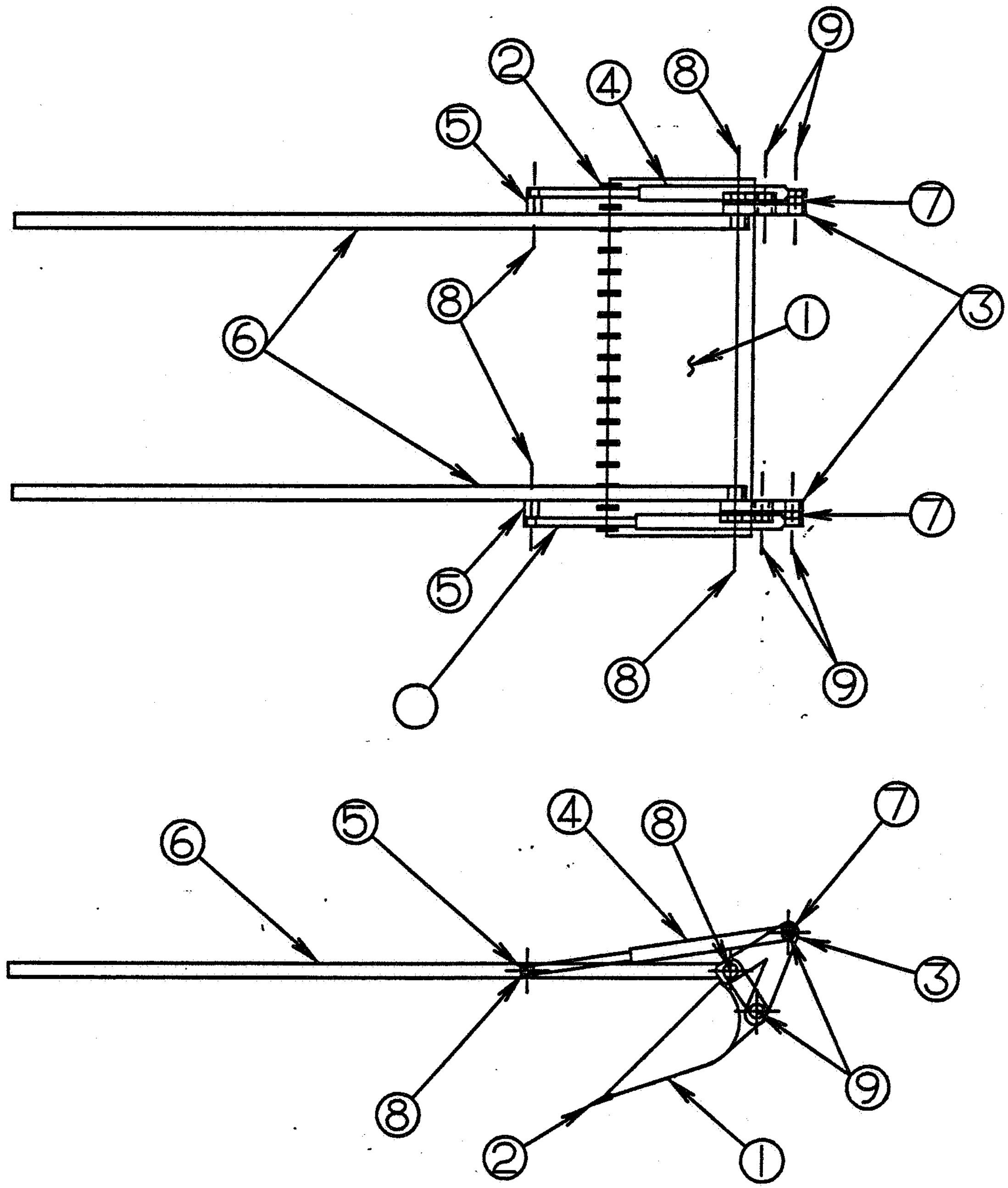


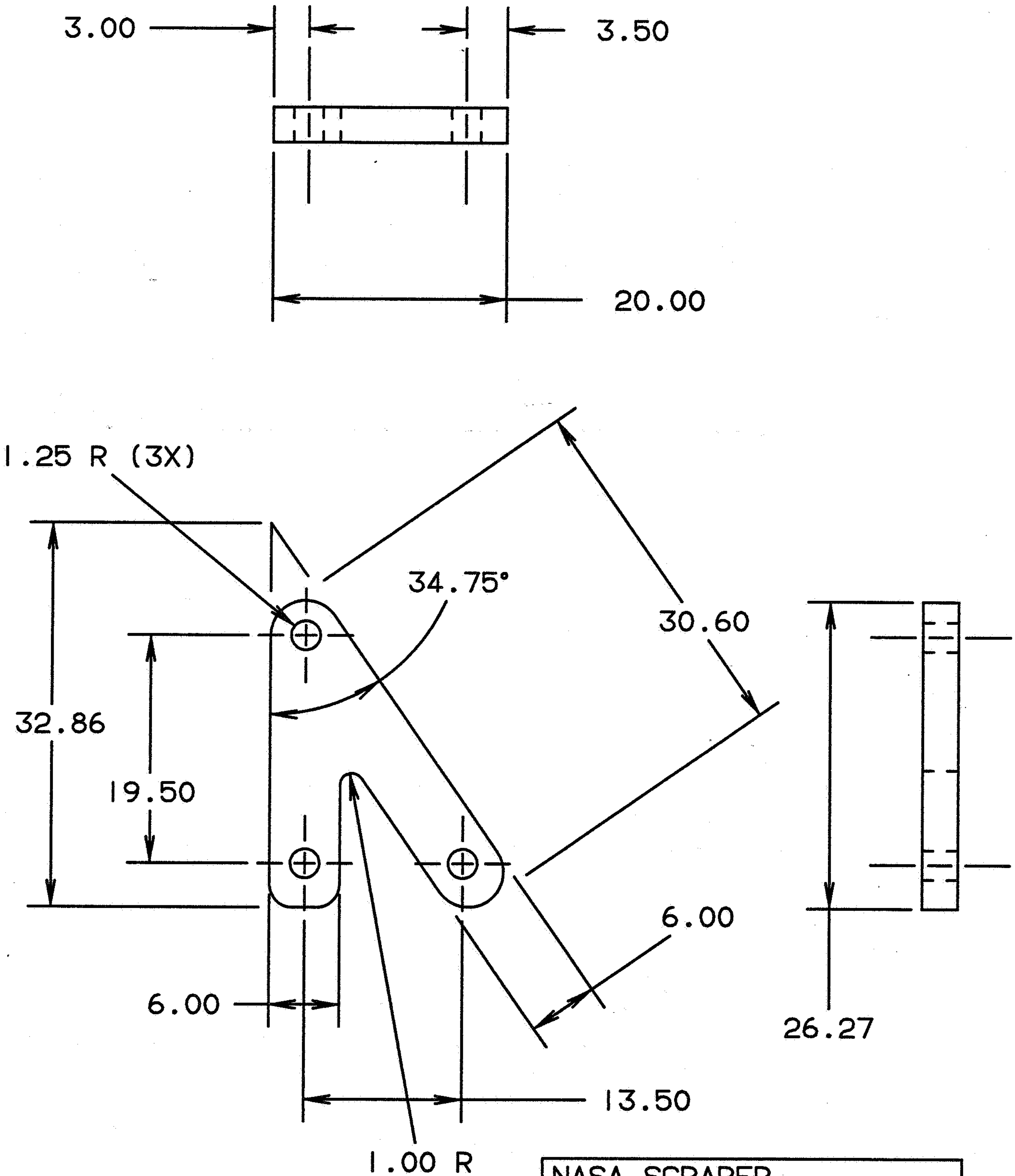
NASA SCRAPER		
NAME: Track Idlers		
SCALE	DRW. # T-7	DATE 3/14

SUBSYSTEM: Track Idlers

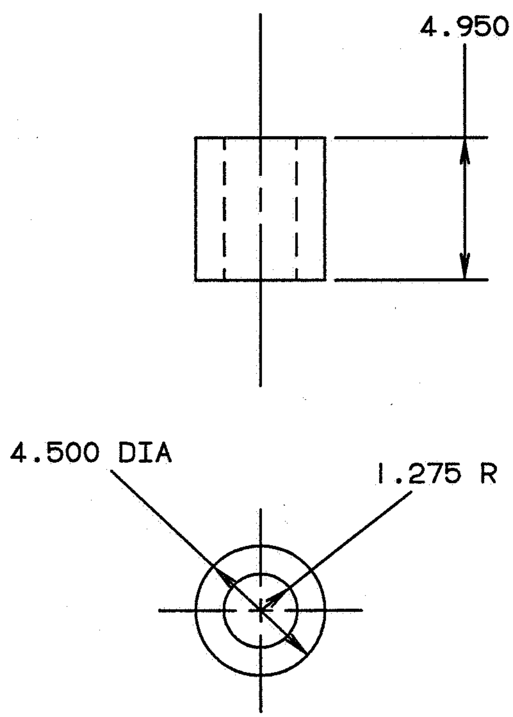
ITEM#	QTY	DESCRIPTION	VENDOR	COST
1	2	Cap Screw		
2	2	Washer		
3	2	O- Ring		
4	2	Pipe Plug		
5	1	Bracket (Inside)		
6	8	Lock Washer		
7	8	Cap Screw		
8	2	Seal Kit		
9	1	Bracket (Outside)		
10	12	Screw		
11	2	Ring		
12	2	Plate		
13	2	Gasket		
14	1	Shaft		
15	2	Bushing		
16	1	Idler		

NASA SCRAPER		
NAME: SCOOP SUBASSEMBLY		
SCALE NONE	DRW.# SC-1	DATE 3/14/85



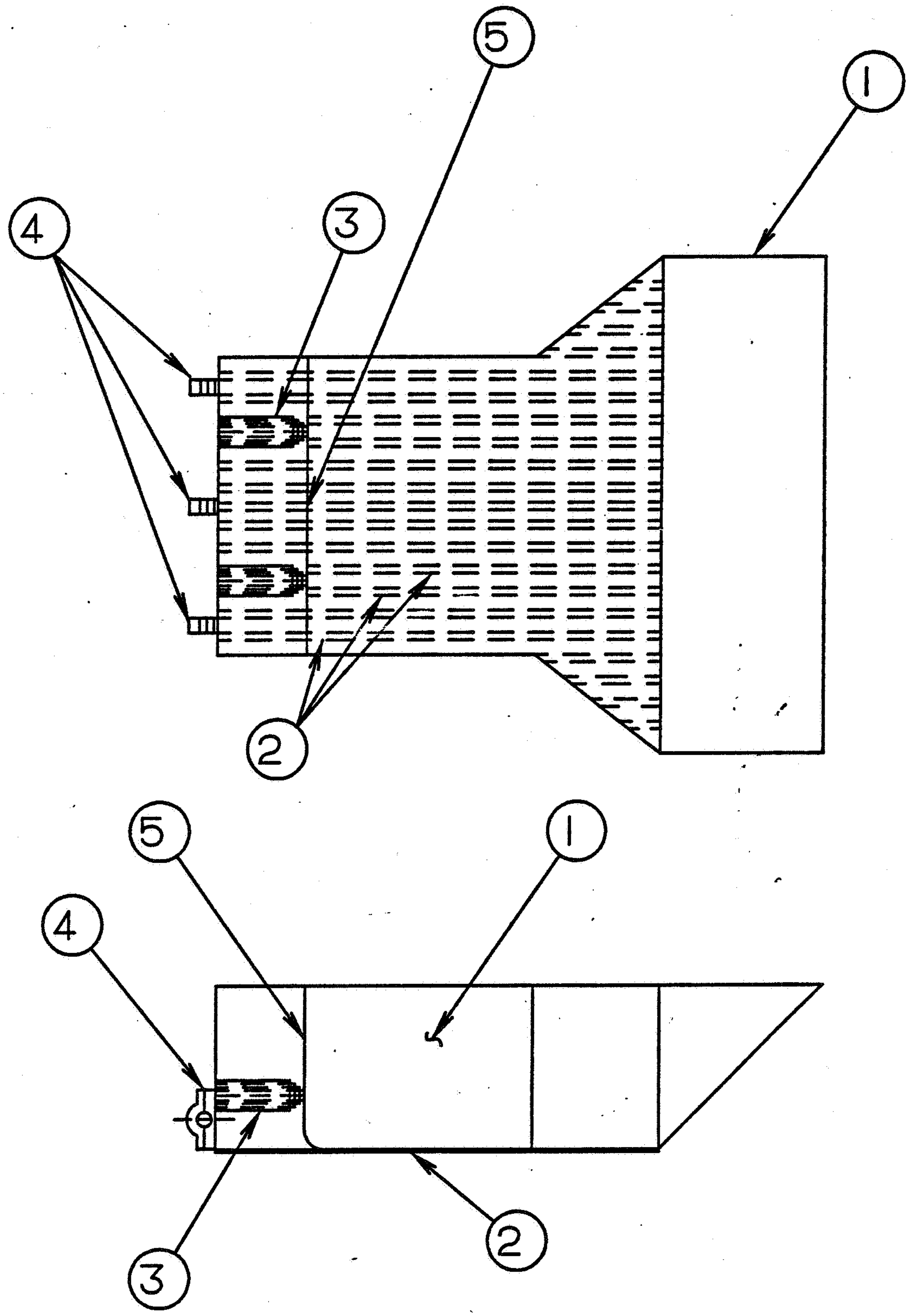


NASA SCRAPER		
NAME: SCOOP BRACKET		
SCALE .08	DRW.# 303	DATE 3/12/85

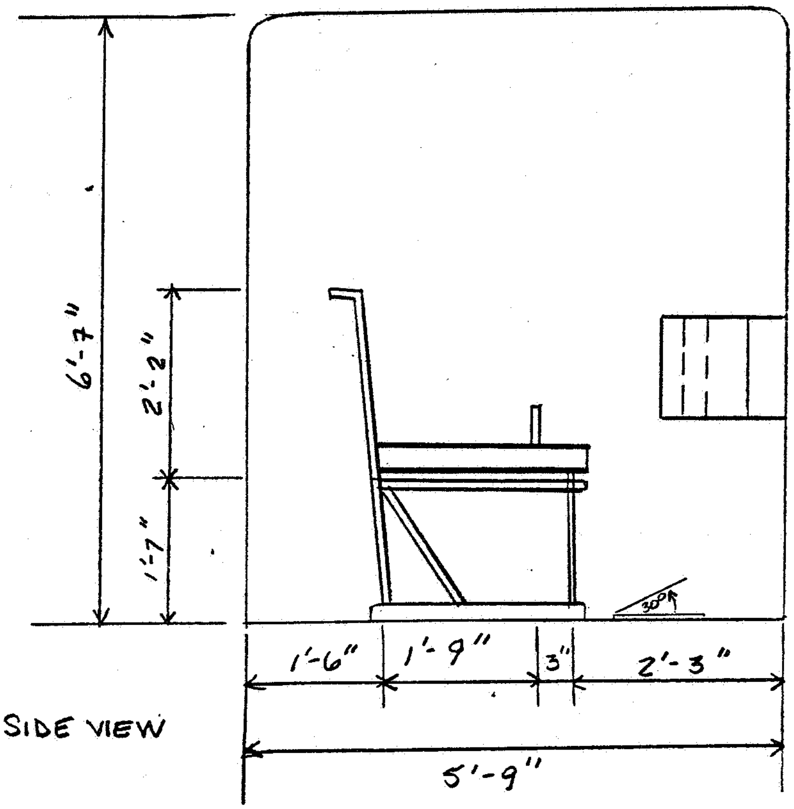


NASA SCRAPER		
NAME: EXTENSION BLK.		
SCALE .20	DRW.# 305	DATE 3/12/85

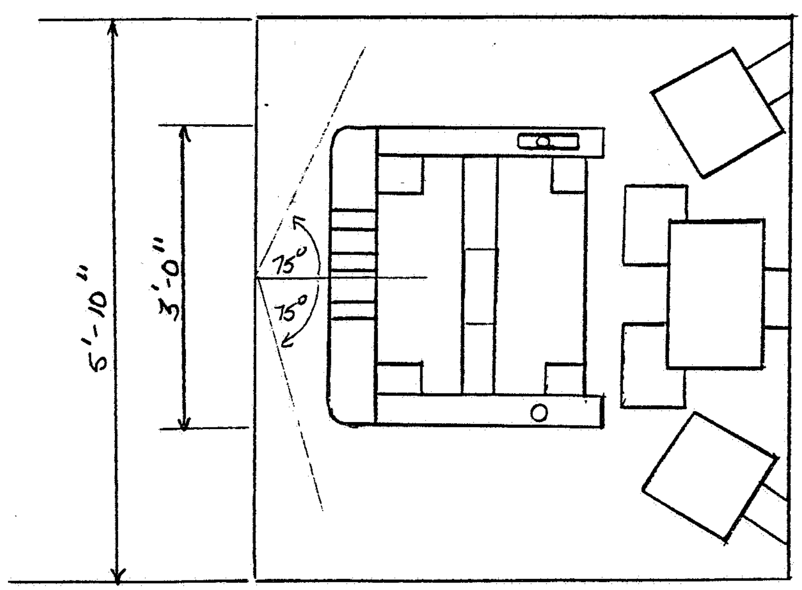
NASA SCRAPER		
NAME: PAN ASSEMBLY		
SCALE	DRW. #	DATE
NONE	P-1	3/14/85



Cab Subassembly



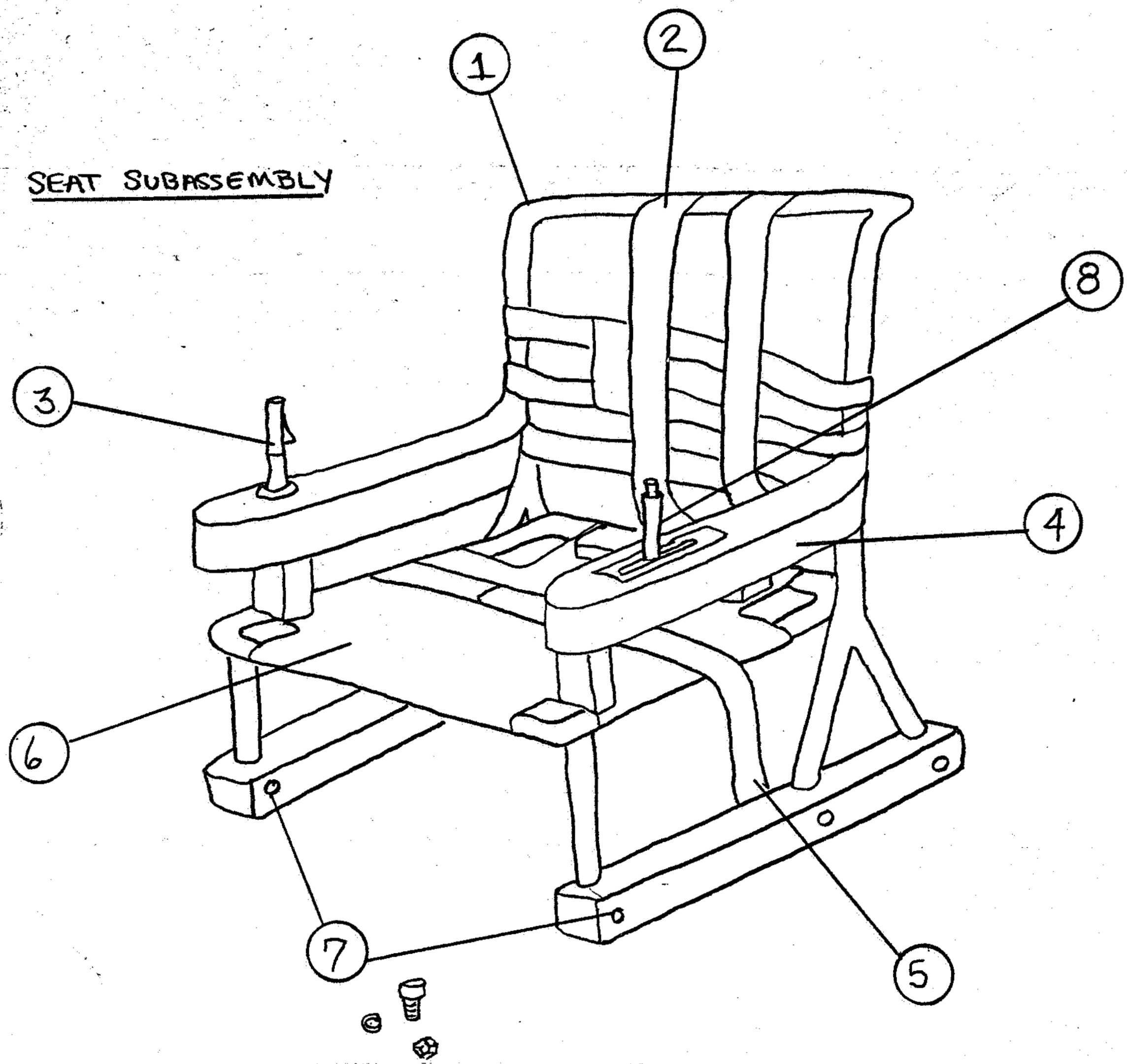
SIDE VIEW



TOP VIEW

NASA SCRAPER		
NAME:		
SCALE	DRW. #	DATE
1/8" = 1'-0"	C-2	3/19/85

SEAT SUBASSEMBLY



1 FRAME

2 BACK

3 RIGHT-HAND CONTROL

4 ARM REST

5 SEAT BELT

6 SEAT

7 BASE SUPPORT & PARTS

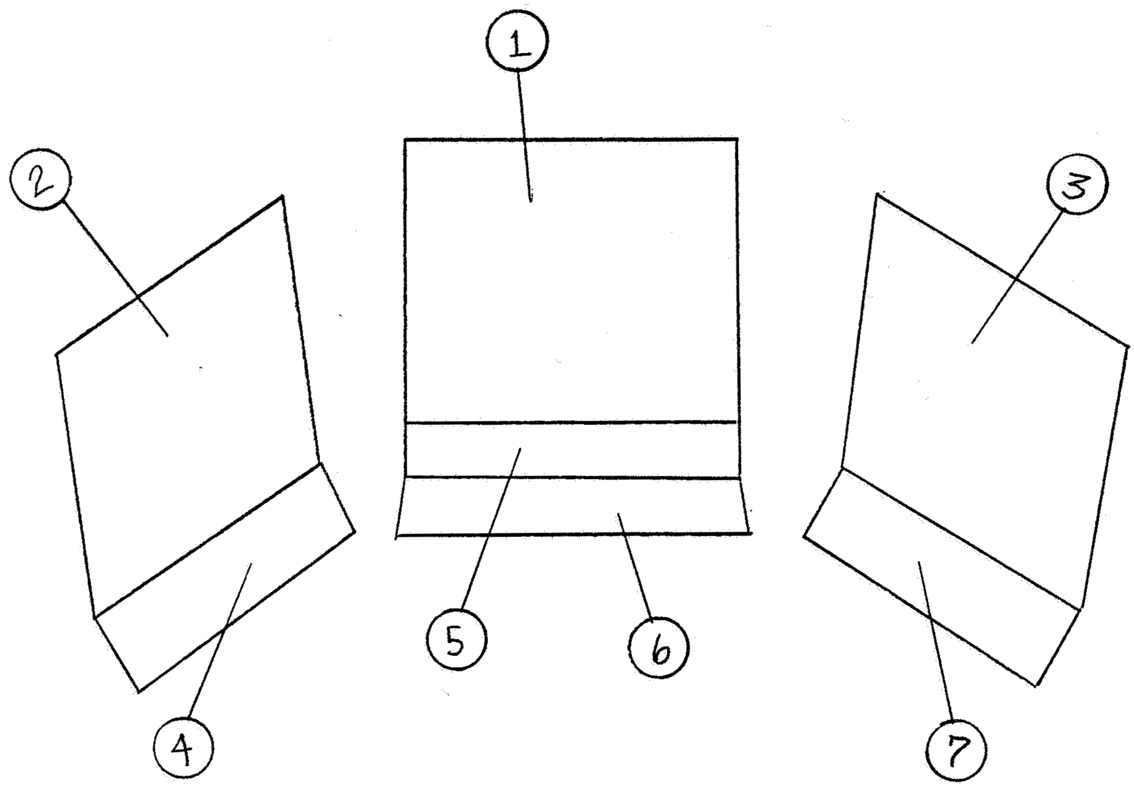
8 LEFT-HAND CONTROL

NASA SCRAPER		
NAME: SEAT		
SCALE	DRW. # C-2	DATE 3/14/85

SUBSYSTEM: CAB SEAT

ITEM#	QTY	DESCRIPTION	VENDOR	COST
1	2 - 16' Length	FRAME - TUBULAR	RYERSON	$50
		ALUMINUM 3/4" O.D.;		
		0.065" THICK, 0.165 lb/ft		
2	5 YRDS	SEAT BACK - NYLON WEBBING		$1.50/YRD
		6" WIDE		
3	2	CONTROL HANDLE	U 43703	
4	2	ARM REST - FIBERGLASS	JOHN DEERE	
5	1 YRD	SEAT BELT FASTENERS		$2.00/YRD
		VELCRO		
6	2 YRDS	SEAT - NYLON		$4.00/YRD
		1'-3" WIDE		
7	2	BASE SUPPORT		
	12 SETS	CAP SCREW 3/8" x 3/4"	T 23876	
		NUT 3/8"	T 23928	
		LOCKWASHER 3/8"	T 23878	

DISPLAY AND CONTROL SUBASSEMBLY



LEGEND

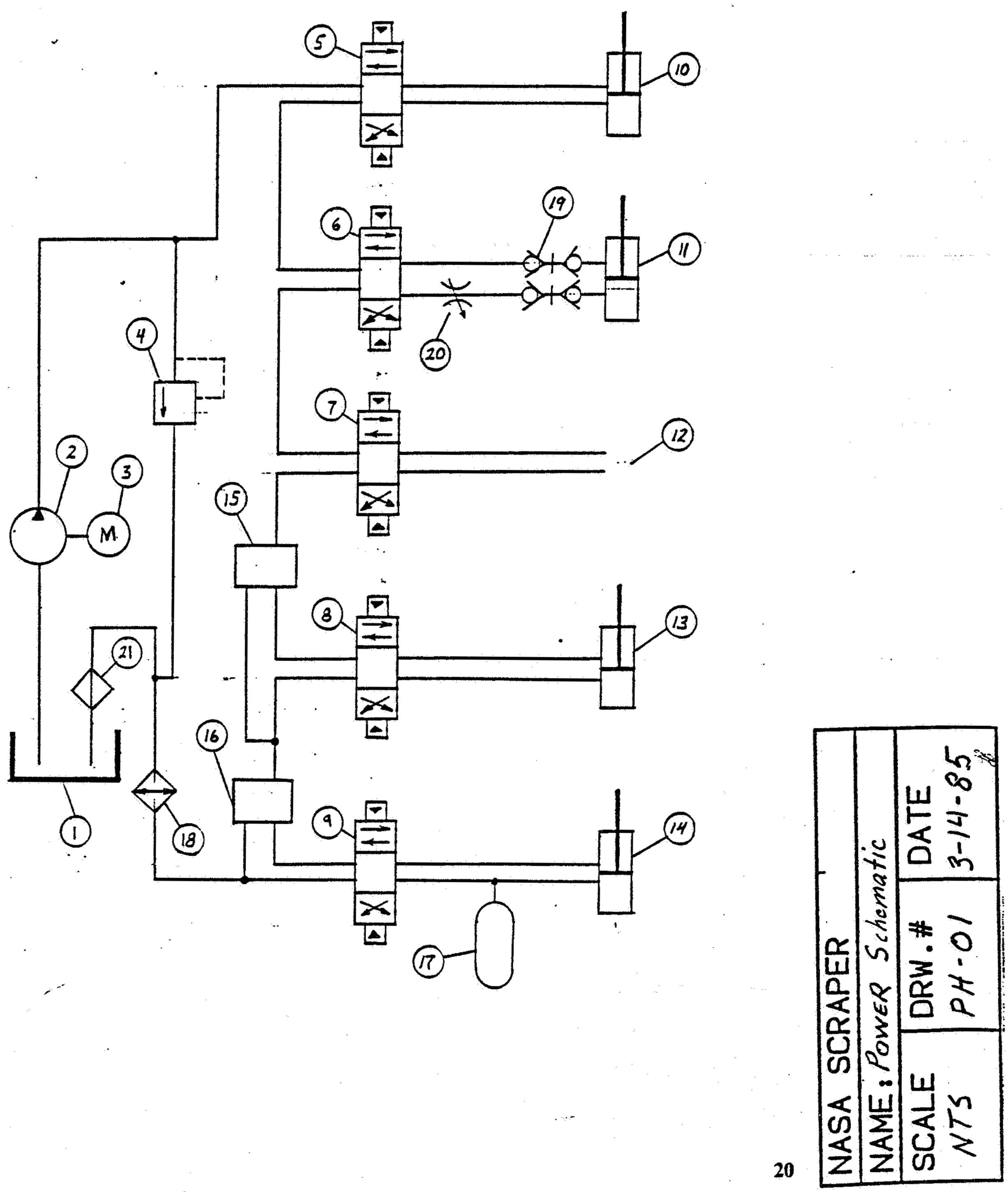
1. MAIN MONITOR - DISPLAY IMPORTANT INFO
2. SWITCHABLE MONITOR - ON BOARD CAMERAS ; FORWARD / REAR VIEW
3. AUXILLARY VIDEO MONITOR -
4. CAMERA SELECTOR / COMMUNICATION DEVICES
5. POWER / DRIVE SWITCHES
6. CIRCUIT BREAKERS
7. AUXILLARY SUBSYSTEM SWITCHES

NASA SCRAPER	
NAME: DISPLAY VIDEO	
SCALE N/A	DRW. # C-3
DATE 3/14/85	

SUBSYSTEM: CAB- VIDEO CONSOLE

ITEM#	QTY	DESCRIPTION	VENDOR	COST
1	3	CRT DISPLAY MONITOR	SONY	$ 350 ea.
2		"	"	
3		"	"	
4	4	SWITCH PANELS;	SONY	
5		SWITCHES; CIRCUIT		
6		BREAKERS		
7				

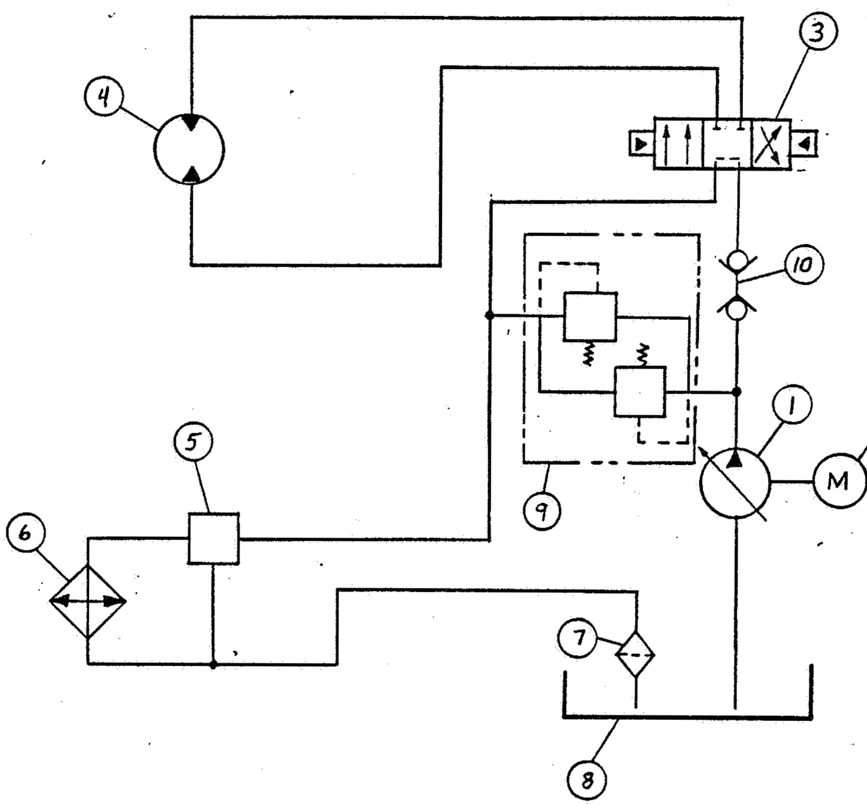
Power / Hydraulics System



SUBSYSTEM: POWER / HYDRAULICS SYSTEM

ITEM#	QTY	DESCRIPTION	VENDOR	COST
1	1	Fluid Resevoir	manufactured	
2	1	Pump, Fixed displacement	Hydreco	
			1510 H	
3	1	Motor, D.C. Electric	Boston Gear	
			M327 TF-B	
4	1	Valve, Relief	Snap-tite	
			RDC-22	
5,6,7,8,9	1 each	Valve, 4 way 3 position	Dukes	
		tandem center	DV-120TD2HB	
10	2	Linear Actuator, Scoop	Dukes	
			WT-4048	
11	2	Linear Actuator, Bucket	Dukes	
			WT-4030	
12	2	Linear Actuator, Ram		
13	2	Linear Actuator, Pan	Dukes	
			WT-3012	
14	2	Linear Actuator, Track	Dukes	
			WT-1506	
15	1	Valve Relief	Snap-tite	
			RDC-22	
16	1	Valve Relief	Snap-tite	
			RDC-22	
17	2	Accumulator	EMG	
			AU 2520	
18	1	Heat Exchanger	manufactured	
		12,000 BTU/hr		
19	1	Coupling Quick Disconnect	Snaptite	
		with checks	29N12-56	
			29N12-49	
20		Valve deceleration		
21	1	Filter	Schroeder	
			RT-1KM10	

Drive System Power / Hydraulics



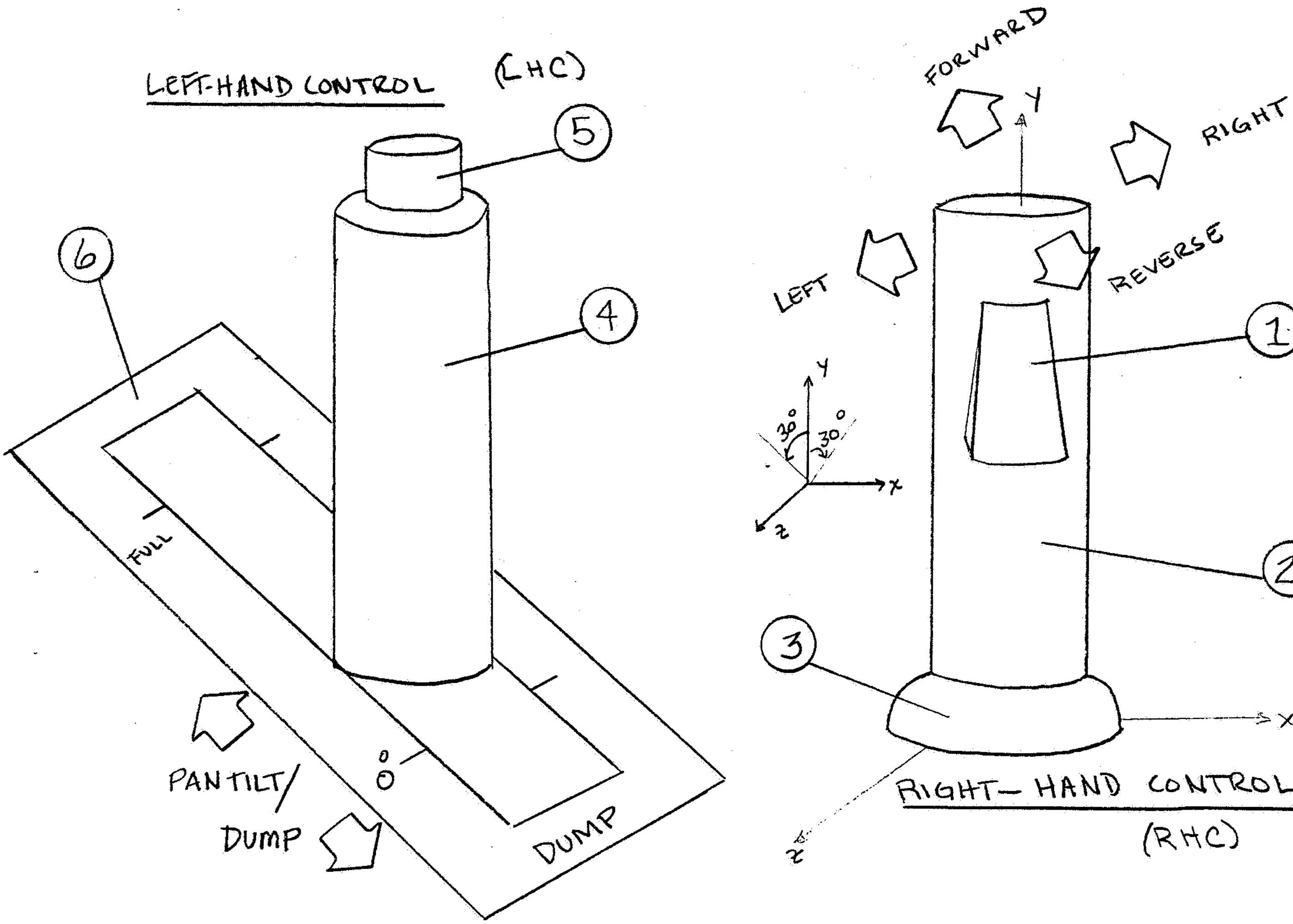
NASA SCRAPER		
NAME: Drive Schematic		
SCALE NTS	DRW.# DH-01	DATE 3-14-85

SUBSYSTEM: DRIVE SYSTEM POWER/HYDRAULICS

ITEM#	QTY	DESCRIPTION	VENDOR	COST
1	2	Pump, Variable displacement	Rexroth	
			1PV2V4-10/50R	DM160A1
2	2	Motor, D.C. Electric	Boston Gear	
			M3210 T/TN	
3	2	Valve, 4 way - 3 position	Dukes	
		tandem center	DV-120TD1HB	
4	2	Motor, hydraulic drive	Rexroth	
			CH(B)300/430	
5	2	Valve	Brand	
			FG528	
6	2	Heat Exchanger	manufactured	
		40,000 BTU/hr		
7	2	Filter	Schroeder	
			RT-1KM10	
8	1	Fluid resevoir	manufactured	
9	2	Valve, relief	Snap-tite	
			MDD-22	
10	2	Coupling, Quick Disconnect	Snap-tite	
		with checks	29N12-56	
			29N12-49	

Drive Controls

HAND CONTROLS (SEAT SUBASSEMBLY)



LEGEND

1. REVERSE SWITCH - RHC
2. HAND JOYSTICK - RHC
3. BASE CAP - RHC
4. HAND GRIP - LHC
5. SCOOP EXTEND BUTTON - LHC
6. CONTROL FACE PLATE

NASA SCRAPER		
NAME: HAND CONTROLS		
SCALE N/A	DRW. # D-1	DATE 3/14/85

SUBSYSTEM: CAB- HAND CONTROLS

ITEM#	QTY	DESCRIPTION	VENDOR	COST
1	1	BUTTON (RHC)		
2	1	JOYSTICK HANDLE	U 43703	
3	1	BASE CAP (RHC)	1 R 8701	
4	1	HANDLE GRIP (LHC)	L1170	
5	1	BUTTON (LHC)		
6	1	CONTROL FACE PLATE	JOHN DEERE	

Alternative Designs

References

Livingston & Haven, Inc FLUID POWER DIGEST, copyright 1982, P.O. BOX 7207, Charlotte, Charlotte, N.C. 28217

BOSTON GEAR, Catalog ep 78

Nicholas L. Johnson, HANDBOOK OF SOVIET LUNAR AND PLANETARY EXPLORATION , Volume 47, Publisher American Astronautical Society Publication

APPOLLO 17, PRELIMINARY SCIENCE REPORT , Copyright 1973

John Deere Dubuque Works PC-1443, Parts Catalog, Litho in USA, May 1983.

Construction Equipment , Vol. 17 no.4 , Cahners Publishing, Oct. 1984.

Industry Standards, VSMF Cart. 1265, June 1974, Frames 2718 - 2738.

Spaceflight 10:42-45 Feb. 1968 "Lunar Roving Vehicles".Def. Trans.

Journal J25 :30-32 Sep.-Oct. 1969 "Mobility For Moon Exploration"

Spaceworld F-1-61 : 12-13 Jan. 1969

Military Engr. 62:306-307 Sep.-Oct. 1970 "Dual Mode LRV"

Spaceworld G-5-77:38-40 May 1970 "First Car On The Moon" reprint from Boeing Magazine Feb. 1970 "Boeing LRV"

Spaceflight 12: 270-274 Jul. 1970

Spaceworld G-9-81 :16-17 Sep. 1970 "The Markow LRV Wheel"

Spaceflight 13 : 135 Apr. 1971 "First Moon Tyre"

Military Engr. 63:25-27 Jan.-Feb. 1971 "The Lunar Rover"

Spaceworld H-7-91 : 44-45 Jul. 1971 "The Lunar Rover and Navigation System"

Spaceworld H-12-96: 12-25 Dec. 1971 "Lunar Roving Vehicle"

Spaceflight 13:90-91 Mar. 1971 "Lunokhod 1"

Spaceworld H-9-93: 9-11 Sep. 1971 "Moon Tires Are Flat Tires on Earth"

Spaceworld H-4-88: 25-27 Apr. 1971"The Moon : Travel On Wheels"

Spaceworld H-10-94: 4-37 Oct. 1971 "On The Moon with Apollo 15"

Soviet Mil. Rev. NO.1: 10-11 Jan. 1971

Spaceworld H-4-88: 34-36 Apr. 1971

Military Engr. 64: 82-84 Mar.-Apr. 1972 "Lunar Mobility Research"

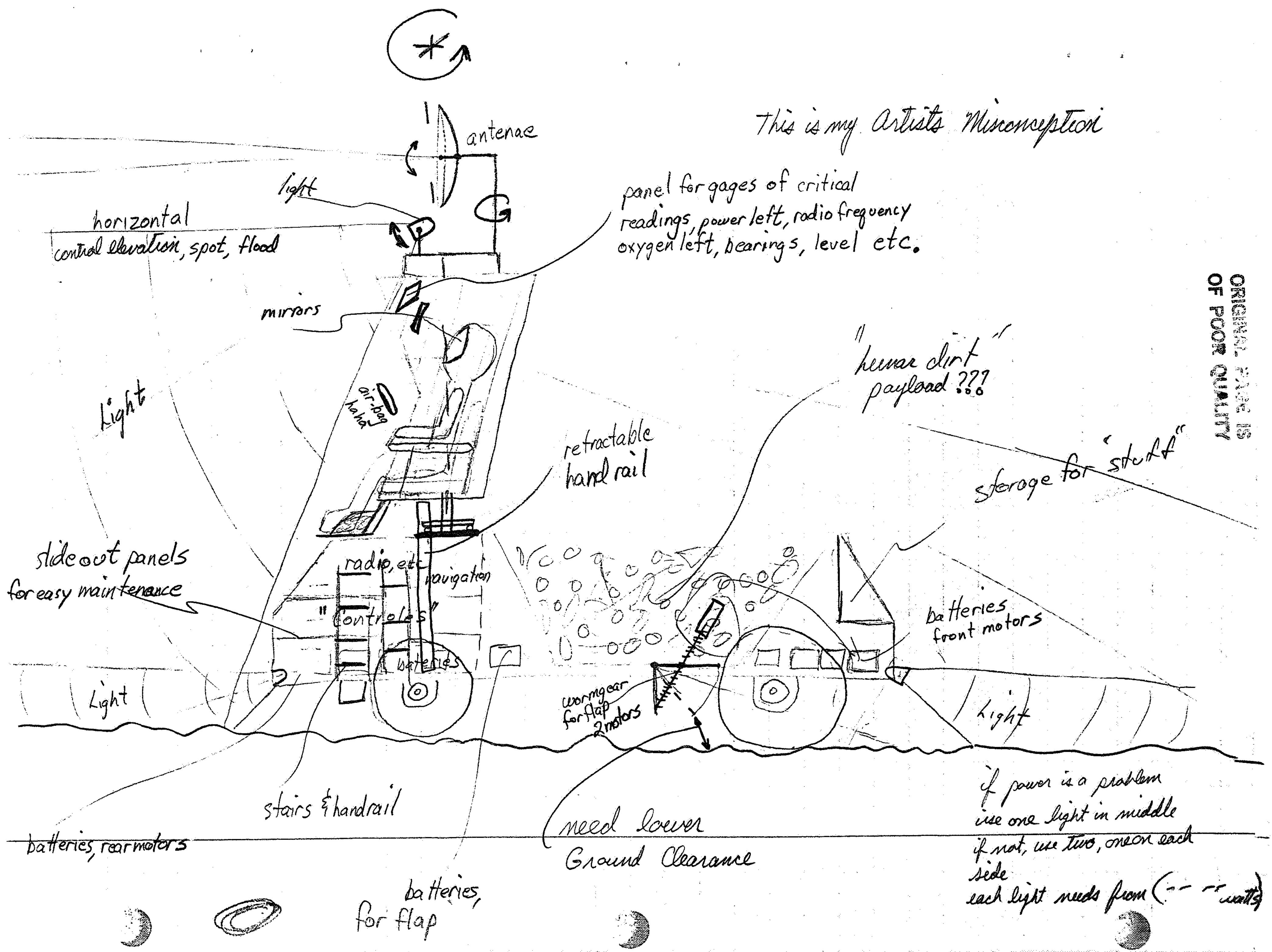
Military Engr. 64: 322-325 Sep.-Oct. 1972 "Roving Vehicle on The Moon"

Spaceworld J-3-111: 17 Mar. 1973 "Continuous Loop Rover"

Spaceflight 16: 322-326 Sep. 1974

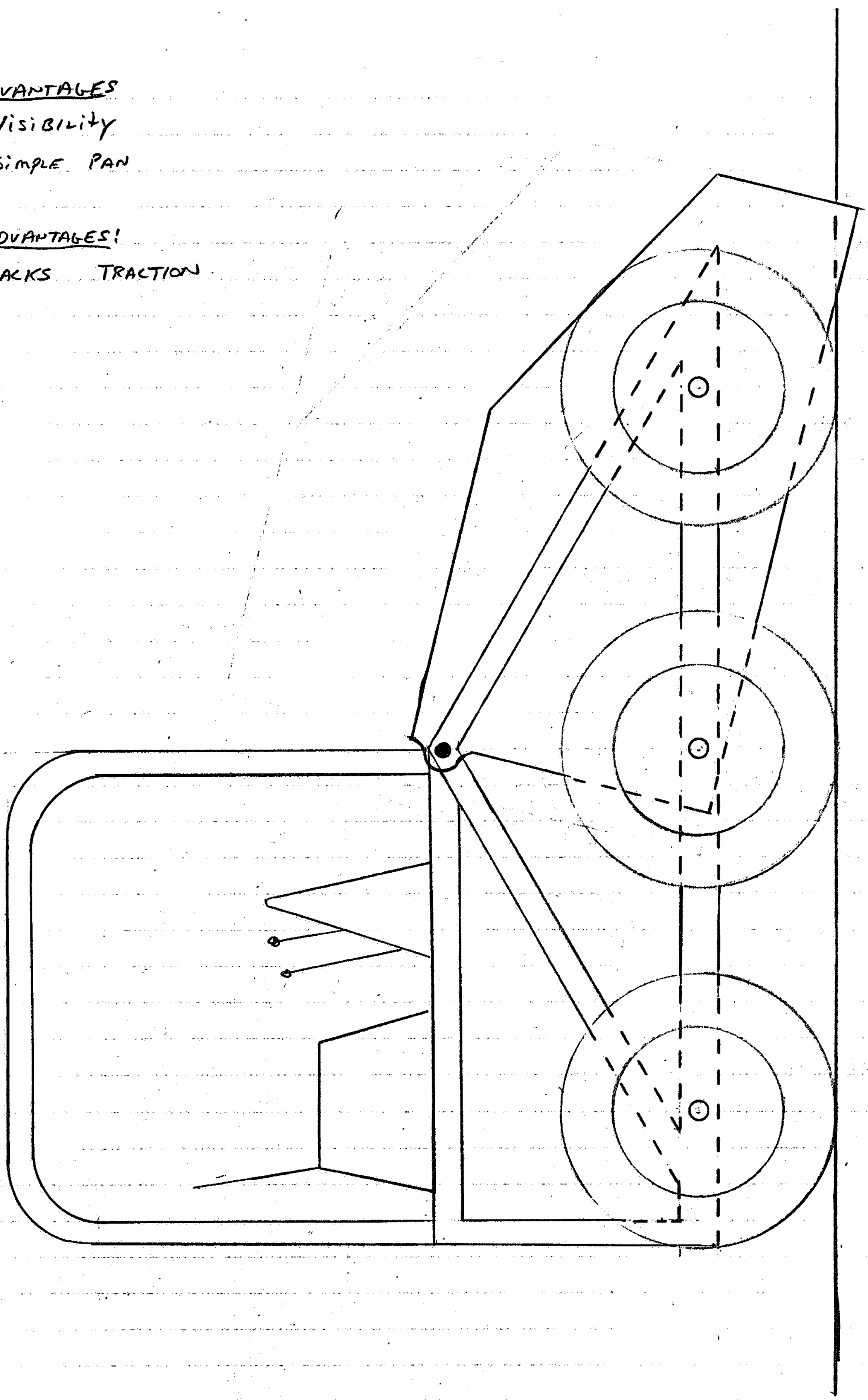
Spaceflight 16: 175-178 May 1974

"Lunar Roving Vehicle Thermal Control System", R.G. Elliot, C.J. Paoletti, M.A. Britt, (Boeing Co., Saturn/Apollo/Skylab Div., Huntsville, Al.). A.S.M.E., Environmental Control And Life Support Systems Conference , San Francisco, Ca.,Aug 14-16, 1972.


This is my Artists Misconception
antenae
light
horizontal
control elevation, spot, flood
panel for gages of critical readings, power left, radio frequency oxygen left, bearings, level etc.
mirrors
air-bag haha
Light
retractable hand rail
"lunar dirt" payload ???
storage for "stuff"
slideout panels for easy maintenance
radio, etc
navigation
"controles"
batteries
batteries front motors
wormgear for flap 2 motors
Light
Light
stairs & handrail
need lower Ground Clearance
batteries, rearmotors
batteries, for flap
if power is a problem use one light in middle
if not, use two, one on each side
each light needs from (-- -- watts)

ADVANTAGES
1) VISIBILITY
2) SIMPLE PAN

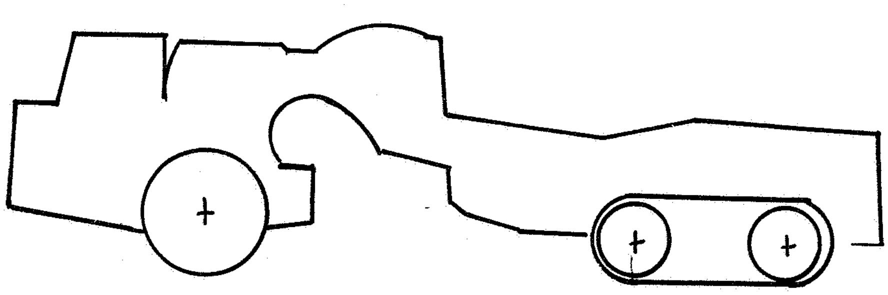
DISADVANTAGES!
1) LACKS TRACTION



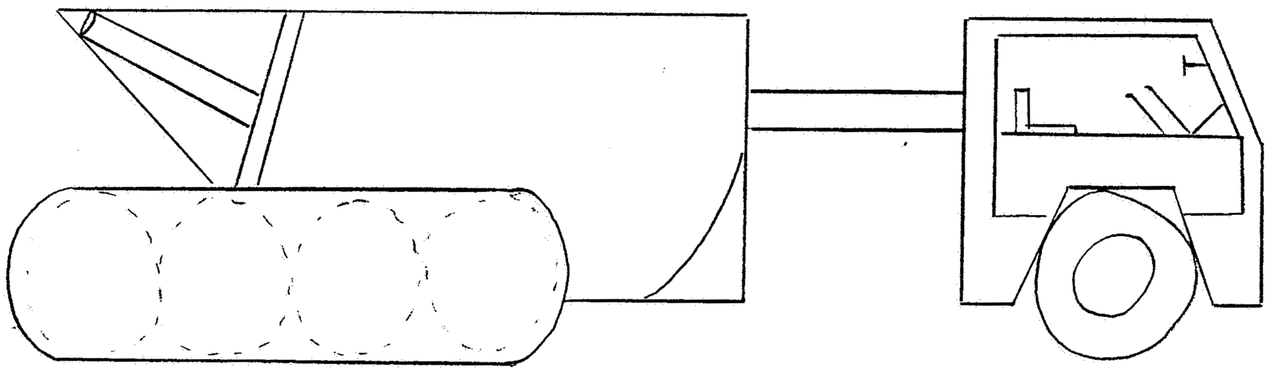
Design Alternative

This design employs a cab separate from the scraper. The cab and tractor are individually powered. The cab has motors mounted in each wheel, and the scraper is driven by hydraulic motors. Two double-acting hydraulic cylinders located between the cab and scraper will serve to turn the vehicle.

This design is not feasible because of the limited mobility the driver has in a space suit. The driver would not be able to check behind him while the scraper is in operation. Additional power, which is in limited supply, is also needed for the cab. This cannot be avoided because the turning action between the cab and scraper would tend to slide the cab if it was not powered.



DESIGN ALTERNATIVE



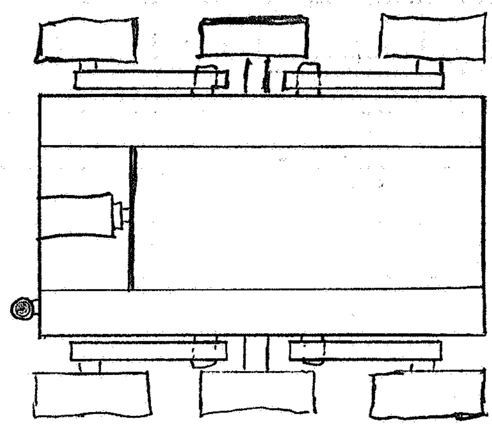
NON-ARTICULATED PAN-TRUCK / WHEEL SYSTEM

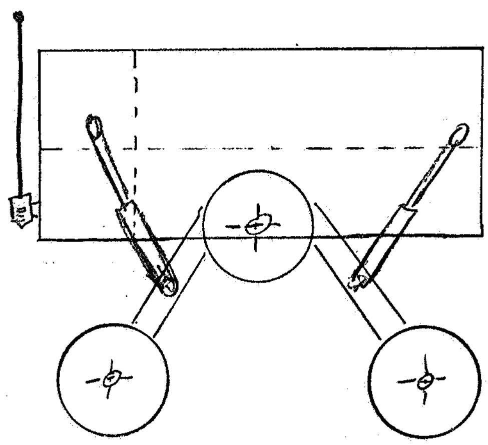
ADVANTAGES: STEERABLE FRONT WHEELS
ELIMINATION OF MOVING PARTS BETWEEN CAB & PAN
GOOD TRACTION WITH TRACKS

DISADVANTAGES: NOT INNOVATIVE ENOUGH
WHEELS SCRUBBING IN TURNS

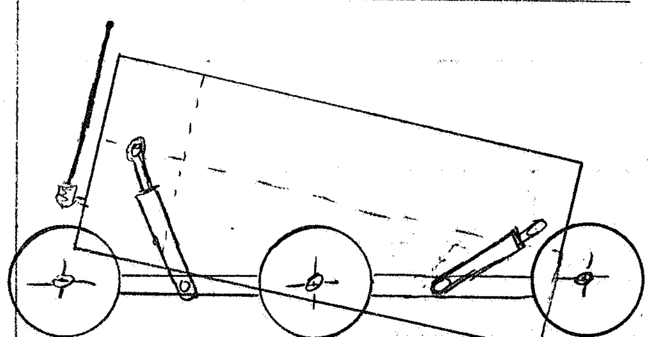
NASA SCRAPER	NAME:	SCALE
		DRW. #
		DATE

DESIGN ALTERNATIVE 6   REMOTE CONTROLLED, ADJUSTABLE CLEARANCE PAN/SCRAPER





(TRANSPORT MODE)



(SCRAPE MODE)

PROS: VERY SAFE
FAIRLY SIMPLE
USES LUNAR ROVER WHEELS

CONS: STRESSES AND MOMENTS IN WHEEL STRUTS
TRACTION PROBLEM

Weekly Progress Reports

Appendix A.

ME 4182 WEEKLY PROGRESS REPORT

PERIOD: 1/10/85 THRU: 1/17/85 TEAM NO.: Th 3:30

TITLE: Lunar Surface Preparation Vehicle for NASA

COMMENTS:

Reseached information on thermal characteristics of Lunar surface, the Lunar Roving Vehicle used in the Apollo Missions, possible power systems to be used in the vehicle, materials to withstand the Lunar environment, and heavy-construction/earth-moving equiptment.

Preliminary design considerations were discussed and rough sketches of initial concepts were solicited from all group members in a brain-storming effort.

Located NASA personnel who worked on the Lunar Rover / space power systems /and bearings and lubrication.

The need for more information concerning size constraints, degree of assembly, and transportation requirements from the Earth was established.

Future meeting times scheduled, individual responsibilities discussed.

	HOURS			
NAME, INITIALS	ENGINEERING	TECHNICIAN	CLERICAL	TOTAL
1) Hurley, C.			2.5	2.5
2) Insolia, G.	2		3	5
3) Leon, M.	2.5		2	4.5
4) Robertson, J.	2			2
5) Scheffler, W.			2	2
6) Vallelian, D.			2	2
TOTALS =	6.5		11.5	18

ME 4182 WEEKLY PROGRESS REPORT

PERIOD: ______ THRU: Jan 25-31 TEAM NO.: TH 3:30

TITLE: Lunar Site Preparation Vehicle for NASA

COMMENTS:

Our primary allocation of time involved the search for background materials. Jack performed an on-line database search while in Huntsville. More information is still on its way. Data was obtained from the VSMF on cab dimensions, visits were made to local construction equipment distributors. Research was performed regarding lubrication coatings on NASA LRV. Information was found on Soviet LRV's and on lunar soil mechanics.

NAME, INITIALS	HOURS ENGINEERING	TECHNICIAN	CLERICAL	TOTAL
1) Leon, M.	1		4	5
2) Robertson, J.			20	20
3) Hurley, C.	2		3	5
4) Scheffler, B.	1		3	4
5) Insola, G.	1		4	5
6) Vallelian, D.	1		4	5
TOTALS =	6		38	44

ME 4182 WEEKLY PROGRESS REPORT

PERIOD: ____________ THRU: FEB. 1-7 TEAM NO.: TH 3:30

TITLE: Lunar Site Prepartion Vehicle for NASA

COMMENTS:

A trip was made to Yancy and Marco Polo construction companies to look at the design of a pan. Group members read literature on the lunar rover, cab specifications, and lunar soil conditions. A production meeting was held Sunday where several design options were evaluated and an initial design was selected.

MEETING MINUTES

- Pan payload constraints decided on
- Max. vehicle weight established
- Need to find a torque vs. vehicle weight requirement - based on only source will be approximately 5 lb. vehicle wt. per 1 ft. lb. torque
- Design options evaluated and a ' best' option was selected to begin design
- System components were identified and divided among group members for research, develope, and design

NAME, INITIALS	HOURS			
	ENGINEERING	TECHNICIAN	CLERICAL	TOTAL
1) Leon, M.	2		3	5
2) Robertson, J.	3		3	6
3) Hurley, C.	6		2	8
4) Insolia, G.	4		3	7
5) Vallelian, D.	3		2	5
6) Schreffler, B.	3		3	6
TOTALS =	21		16	37

ME 4182 WEEKLY PROGRESS REPORT

PERIOD: Feb. 8 THRU: Feb.14 TEAM NO.: Th3:30

TITLE: Lunar Site Preparation Vehicle for NASA

COMMENTS:

Information obtained from NASA library in Huntsville, Al. dispersed among group members..

Alternative designs for scraping method designed by group members.

Related topics investigated in "Construction"and "Compressed Air" periodicals.

Center of gravity studies of possible pan beds performed.

New information obtained on related projects.

Equipment observed in action at construction site

NAME, INITIALS	HOURS ENGINEERING	TECHNICIAN	CLERICAL	TOTAL
1) Hurley, C.	1		2	3
2) Insolia, G.	2		1	3
3) Leon, M.	3			3
4) Robertson, J.			5	5
5) Scheffler, W.			3	3
6) Vallelian, D.	.5		3	3.5
TOTALS =	6.5		14	20.5

ME 4182 WEEKLY PROGRESS REPORT

PERIOD: ____________ THRU: Feb 13-21 TEAM NO.: TH 3:30

TITLE: Lunar Site Preparation Vehicle for NASA

COMMENTS:

This week was spent discussing and deciding on various design proposals. The group met on a couple of occasions and selected the design for final analysis. Through use of the CADAM system, preliminary drawings and revisions are being made.

NAME, INITIALS	HOURS ENGINEERING	TECHNICIAN	CLERICAL	TOTAL
1) Leon, M.	3			3
2) Robertson, J.	3		1	4
3) Hurley, C.	2.5		1	3.5
4) Schreffler, W.	2.5			2.5
5) Insolia, G.	2	3		5
6) Vallelian, D.	2		2	4
TOTALS =	15	3	4	22

ME 4182 WEEKLY PROGRESS REPORT

PERIOD: Feb. 22 THRU: Feb 28 TEAM NO.: TH 3:30

TITLE: Lunar Site Preparation Vehicle For NASA

COMMENTS:

The final drawings were completed this week on the CADAM system. This System was also used to model the hydraulics, as well as a micropressing unit to help in the typing of the final report.

NAME, INITIALS	HOURS ENGINEERING	TECHNICIAN	CLERICAL	TOTAL
1) Insolia, G	18			18
2) Vallelian, D.	10		2	12
3) Hurley, C.	4.5		1.5	6
4) Leon, M.	9		2	11
5) Robertson, J.	.5		1	1.5
6) Schreffler, B.	2		1	3
TOTALS =	44	0	7.5	51.5

ME 4182 WEEKLY PROGRESS REPORT

PERIOD: March 1 THRU: March 7 TEAM NO.: TH 3:30

TITLE: Lunar Surface Preparation Vehicle for NASA

COMMENTS:

Group meeting to detail subsystems, set pace for rest of quarter.

Researched NASA documents in library

Partial completion of hydraulics design and specification

Preliminary drawings updated, clarified

Rough draft of final report compiled - necessary parts of final report exist but need to be rearranged into final format.

Detailed drawings of subsystems need to be completed.

NAME, INITIALS	HOURS ENGINEERING	TECHNICIAN	CLERICAL	TOTAL
1) Cindy Hurly	8			8
2) Mike Leon	4			4
3) Gerard Insolia	6		2	8
4) Jack Robertson	6			6
5) Bill Schreffler	5		3	8
6) Daniel Vallelian	14		3	17
TOTALS =	43		8	51

"Design For Lunar Environment", Richard E. Wong and Louis Galan (Aerospace Sys. Div. Bendix Corp.) Lynn L. Bradford (Marshall Space Flight Center, NASA), Automotive Engineering Congress, Detroit, Mich. Jan. 8-12, 1968.

Space Materials Handbook ,Goetzel, Rittenhouse, Singletary, Lockheed Missles And Space Co., Addison-Wesley Publishing Co. Inc., Reading, Mass. 1965

Space Technology , Kenneth Gatland, Harmony Books, One Park Ave., New York, New York,1981.

"Operation profiles for lunar roving missions", C.W.McCormick(Jet Propulsion Lab. California Inst. of Technology),Pasadena, Ca. May 1970.

"Traction Drive system design considerations for a lunar roving vehicle", B.J. Doran, C.S. Jones Jr., F.J. Nola (Marshall Space Flight Center, NASA),Huntsville, Al., Nov. 25,1969.

"Lunar Roving Vehicle - Manned spacecraft on Wheels.", A.F. Field, H.E. Atkins Jr. (Boeing Co.), Huntsville, Al., American Inst. Of Aeronautics and Astronautics, Man's Role In Space Conference, Cocoa Beach, Fla., Mar. 27-28,1972.

"The Apollo Lunar Roving Vehicle", W. haussermann (Marshall Space Flight Center,NASA), Huntsville, Ala. Sep. 6-10, 1971

"Synthesis of a Lunar Surface Base", J.M. Mansfield, D.J. Stone (North American Rockwell Corp., Space Div., Downey, Ca.), New York, AIAA Space Systems Meeting, Denver, Co.Jul.19-20,1971.

"Apollo Lunar Vehicles I,II,III,IV." C.C. Gage, W.S. Parker (Chrysler Corp., New Orleans, La.), E. Markow (Grumman Aerospace Corp., Bethpage, N.Y.), H. Kudish, S. Romano (Boeing Co., Seattle, Wash. , General Motors Corp., Milwaukee,Wis.) SAE Journal, Vol. 78 p.24-31.

"Traction drive system design considerations for a lunar roving vehicle" B.J. Doran, C.S. Jones Jr., F.J. Nola (NASA Washington, D.C.) Society of Automotive Engineers, Society of Automotive Engineers, Automotive Engineering Congress, Detroit, MI., Jan.12-16, 1970.

Fielder,Gilbert, Structure of the Moon's Surface , Pergamon Press, New York 1961

Salisbury,J.W., Glaser,P.E., The Lunar Surface Layer , Academic Press, New York 1964

Tatsch,J.H., The Moon , Tatsch Associates, Sudsbury, Mass 1974

Tenney,D.R., Sykes,G.F., Bowles,D.E., "Space Environmental Effects on Materials", Environmental Effects on Materials for Space Applications , AGARD Conference Proceedings No.327, Toronto, Canada 1982

Mackay,Donald,B., Design of Space Powerplants , Prentice Hall, Inc., Englewood Cliffs, N.J. 1963

Lherbler,L.W., Koffler,R.W., "High Tempurature Sheet Alloys: Properties, Problems, and Potential" , SAMPE Technical Reference Series, 1971

Hepper,R.H., "Boron-Aluminum Structural Components for Shuttle", SAMPE Technical Reference Series, 1971

Loechel,L.W., "High Temperature Metals for Space Shuttle", SAMPE Technical Reference Series, 1971

Osgood,Carl,C., Spacecraft Structures , Prentice-Hall, Inc, Englewood Cliffs, N.J. 1966